Group versus Solo Physical Activity in the Reduction of Stress, Anxiety and Depression

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Signed Declaration

I, Julie Port, declare that this thesis has been composed by me, is my own work, has not been submitted for any other degree or professional qualification except as specified. The work reported in this thesis have been executed by myself, except where due acknowledgement is made in the text.

Signature:

Date: 30th June 2016

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Valar morghulis

Abstract

The physical and psychological health enhancing benefits of physical activity have been well established (US Department of Health & Human Services, 1996; Warburton, Nicol & Bredin, 2006) and reviews support the anxiolytic, anti-depressant and stress reducing effects of physical activity, but it is unclear if group or solo physical activity is more effective in the reduction of these forms of psychological distress. A recent survey found that approximately a third of adults in Scotland do not engage in sufficient levels of physical activity recommended to achieve these benefits. The aim of this thesis was to investigate the effectiveness of group versus solo physical activity in the reduction of psychological distress (including stress, depression and anxiety) and factors involved in participation to promote greater engagement in physical activity. The first study issued questionnaires to members of the general population and university students. Inverse correlations were found between group physical activity and psychological distress in both samples. However a single positive correlation was found between anxiety and solo physical activity in the student sample, which suggests that group physical activity may be more effective in the reduction of psychological distress than solo physical activity. Low active individuals appeared to prefer solo physical activity to group, which may be due to lower perceived barriers. More active participants either preferred group activity or had no preferences between group or solo activity, despite also perceiving greater barriers to group than solo activity.

The second study allocated university students to a group versus solo jogging condition intervention and found that psychological distress increased for those allocated to solo jogging, but did not increase amongst those allocated to group jogging, suggesting that group physical activity may protect against university related distress. Those allocated to group jogging engaged in (non-significantly) more jogging and engaged in significantly more moderately intensive physical activity throughout the intervention than those allocated to solo jogging.

The final study compared group and solo physical activity using the Theory of Planned Behaviour and structural equation modelling. The model explained more

variance in group physical activity than variance in solo physical activity. When the model was expanded, self-efficacy made a significantly greater contribution to intention in the solo physical activity model than it did in the group activity model, therefore promotion of group physical activity may not be as dependent on self-efficacy as solo physical activity. Perceived autonomy support (PAS) was included in the model, as guided by modification indexes, but only the group physical activity model was significantly improved by the addition of PAS; this may be useful for the development of group physical activity promotion. This thesis finds some support that group physical activity may be associated with reduced psychological distress and be more beneficial in protecting against psychological distress than solo physical activity. Promotion of group physical activity may benefit from reducing perceived barriers, developing PAS, and having less reliance on self-efficacy than required for the promotion of solo physical activity.

Lay Summary

The physical and psychological health enhancing benefits of physical activity have been well established and several reviews support the ability of physical activity to reduce distress, but it is unclear if group or solo physical activity is more effective in reduction of distress. A recent survey found that approximately a third of adults in Scotland do not engage in sufficient levels of physical activity to achieve these benefits. The aim of this thesis was to investigate the relative effectiveness of group versus solo physical activity in the reduction of psychological distress (including stress, depression and anxiety) and factors involved in participation to promote greater engagement in physical activity. The first study issued questionnaires to members of the general population and university students. Increased participation in group physical activity was associated with reduced psychological distress in both samples, but not solo activity. This suggests that group physical activity may be more effective in the reduction of psychological distress than solo activity. Low active individuals appeared to prefer solo physical activity to group activity, which may be due to fewer perceived barriers. More active participants either preferred group acitivity or had no preference, despite also perceiving greater barriers to group than solo activity. The second study allocated university students to either a group or solo jogging intervention and found that psychological distress increased for those allocated to the solo condition, but not for those in the group condition, which suggests that group physical activity may protect against university related distress. Those allocated to group jogging engaged in more jogging and more moderately intensive physical activity throughout the intervention than those in the solo jogging group. The final study compared the differences between two models that predict and attempt to explain group and solo physical activity. Self-efficacy made a significantly greater contribution to intention to engage in solo physical activity than it did to intention to engage in group activity; therefore self-efficacy may be less important in the promotion of group physical activity than in the promotion of solo physical activity. Perceived autonomy support (PAS) was included in the models, but only the prediction of intention to engage in group physical activity was significantly improved with the addition of PAS, which may be useful for the development of group physical activity promotion. This thesis finds some support that group physical activity may be associated with reduced psychological distress and be more beneficial in protecting against psychological distress than solo physical activity. Promotion of group physical activity may benefit from reducing perceived barriers, developing PAS, and having less reliance on self-efficacy than required for the promotion of solo physical activity.

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Chapter 1

General Introduction

1.1 Introduction to the Thesis

There were two overall aims of this thesis. The first was to evaluate the relationship between psychological distress and group and solo physical activity. The second was to therefore investigate the factors involved in participation.

The first aim was to examine the effectiveness of group and solo physical activity in improving psychological distress, specifically examining stress, depression and anxiety. The overarching research question was does group physical activity reduce psychological distress more than solo physical activity? To investigate this a systematic review (Chapter 2) was conducted comparing the effectiveness of group versus solo physical activity contexts in reducing psychological distress. Some evidence was found to support that group physical activity may be superior to solo in the reduction of depression. This was further investigated with a cross-sectional survey (with the aim to inform and recruit for an intervention study, Chapter 4) which also found some support that group physical activity may be associated with lower psychological distress than solo. To further test this relationship Chapter 4 included an intervention study that quasi-randomising participants to a group and solo jogging condition which tracked stress, anxiety and depression over a 10 week period and found some evidence for a protective effect of group physical activity over solo in reducing psychological distress.

Having established some support for the benefits of group physical activity, the second aim of this thesis was to investigate the different factors involved in group and solo physical activity, especially for inactive individuals, with the intention of developing further intervention or strategies to facilitate group physical activity. The second overarching research question was what factors are important in promoting group compared with solo? The cross-sectional study mentioned earlier (Chapter 3) also examined preferences, benefits, and barriers to engaging in group and solo physical activity, for both students and members of the general population using a scale developed for this purpose. While it was difficult to differentiate between preferences, greater barriers to group physical activity were found in comparison to solo which highlights the difficulties in engaging in this type of activity despite the potential benefits. The final study compared two models of group and solo physical activity behaviour with the intention of understanding what factors to target for a future intervention to promote group physical activity. The only difference found using an expanded model of the Theory of Planned Behaviour was the relationship between self-efficacy and intention to engage in physical activity. This implied that less self-efficacy may be required when intending to engage in group physical activity which may be important for samples with low levels of self-efficacy at baseline.

1.2 Defining Physical Activity

Physical activity encompasses a wide range of activities including active living, recreational activity, sport, exercise, play and dance (Cavill, Kahlmeier & Racioppi, 2006). “Exercise” and “physical activity” are terms often used interchangeably (Taylor, 1983). However, their conceptualisations differ: physical activity is defined as “any bodily movement produced by skeletal muscles that results in any energy expenditure” while exercise is defined as “planned, structured and repetitive bodily movement done to improve or maintain one or more components of physical fitness” (Caspersen, Powell & Christenson, 1985). While “exercise” and “physical activity” include similar characteristics – both include bodily movement produced by skeletal muscles that expends energy, and are positively correlated with physical fitness as the intensity, duration and frequency of movement increase (Caspersen et al., 1985) – “exercise” is related to the objective of improving or maintaining physical fitness.

In health promotion, Aronson and Oman (2004) suggest individuals respond better to programmes described as promoting physical activity rather than exercise, as the term “exercise” may trigger associations with intense aerobic exercise or calisthenics. In adults and university students, “exercise” has been associated with “pushing oneself”, requiring access to a gym or exercise facility, being performed alone (Tudor-Locke, Henderson, Wilcox, Cooper, Durstine & Ainsworth, 2003), being unenjoyable, and requiring high levels of motivation (Bulley, Donaghy & Mutrie, 2009). Physical activity has been associated with variety of activities, from daily work and home life to structured exercise (Tudor-Locke et al., 2003), being enjoyable, and being an easy way to attain the benefits associated with exercise (Bulley, Donaghy & Mutrie, 2009). To avoid the negative association with intense aerobic exercise or calisthenics, the term physical activity is used throughout the current thesis and when communicating with participants. However, the activity referred to in this thesis involves planned exercise, rather than "any bodily movement produced by skeletal muscles that results in any energy expenditure" (Caspersen, Powell & Christenson, 1985, p.126-130).

This thesis investigates group and solo physical activity contexts. Throughout the studies included in this thesis,"group physical activity" is defined as any activity completed with personal interaction with one person or more who is also engaging in the physical activity. Participants were provided with a prompt including examples such as "group sports (e.g. football), group exercises (e.g. exercise classes or yoga) or any other group physical activities (e.g. walking group)"."Solo physical activity" is defined as being conducted either entirely alone, or in an environment where other individuals are not personally known to them. A prompt was provided suggesting 'using equipment in a gym but not with friends, exercising at home, cycling alone or walks alone'.

Physical activity is conceptualised by its frequency, duration, type, and intensity. Frequency usually relates to the number of times an activity is performed in a given time frame (for example, per week or per month). Duration relates to the number of minutes of physical activity, either per session or as accumulated through a particular time frame. Activity type may relate to aerobic, resistance or flexibility activities, or specify a particular activity, such as swimming or tennis. Intensity refers to the estimated energy expended during a particular activity, and can be estimated with metabolic equivalents (METs). The MET represents a procedure for expressing the energy cost of physical activities as multiples of average resting metabolic rate (Bryne, Hills, Hunter, Weinsier & Schutz, 2005). Resting metabolic rate is the minimum number of calories the body needs to support its basic physiological functions. Ainsworth, Haskell, Whitt, Irwin, Swartz, Strath, O'Brien, Bassett, Schmitz, Emplaincourt, Jacobs and Leon (2002) have described an extensive compendium of physical activities in terms of MET scores. For example, 1 MET is equivalent to the energy used by a person sitting quietly, whereas doubles tennis has been assigned a value of 5 METs. Therefore, the greater effort expended, the higher the MET figure.

There are a number of methods of measuring physical activity which are more accurate than estimation using METs but are impractical for population studies. Methods that measure energy expenditure, such as oxygen consumption through calorimetry or doubly labelled water to analyse the expired air, are expensive and require specific facilities that interrupt usual engagement of physical activity. Recorded observation requires specific equipment, and may be time consuming and expensive. Heart rate monitors and motion sensors, such as pedometers and accelerometers can also be costly, may malfunction or be used incorrectly by participants and, as with recorded observation, may motivate individuals to increase their usual physical activity due to observation (Dishman, Washburn & Schoeller, 2001).

While the true measure of the intensity of any physical activity is relative to an individual's capacity and can only be accurately measured in a laboratory setting (Macera, Hootman & Sniezek, 2006), Ainsworth et al. (2002) state that the compendium was not developed to determine the precise energy cost of physical activity. MET scores were designed to facilitate coding of physical activities from multiple sources such as questionnaires, interviews, diaries or logs (Moy, Scragg, McLean & Carr, 2006). The particular advantage of using MET scores in research is that they provide a common descriptor of activities for use in all populations and allow for ease of comparison (Balady, 2002). It is important to note that MET scores may be less accurate for individuals with decreased functional capacity, such as older adults or those with illness (Norton, Norton & Sadgrove 2010). However, many validated physical activity questionnaires that utilise MET scores (for example, the International Physical Activity Questionnaire, IPAQ, Booth, 2000; Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth,Pratt, Ekelund, Yngve, Sallis & Oja, 2003) provide fairly accurate estimates of physical activity or energy expenditure, especially when distinguishing active individuals from inactive individuals (Pereira, FitzGerald, Gregg, Joswiak, Ryan, & Suminski, 1997; Lamonte & Ainsworth, 2001).

1.3 **Benefits of Physical Activity**

The physical and psychological benefits of physical activity have been well established. Extensive reviews have found engagement in physical activity relates to a reduced risk of cardiovascular diseases, colon and breast cancer, non-insulin-dependent diabetes mellitus, osteoarthritis, obesity, hypertension, and falling, and an improvement in mental health and health-related quality of life (US Department of Health & Human Services, 1996; Warburton, Nicol & Bredin, 2006).

To achieve these benefits, the recommended dose of physical activity for adults includes an accumulation of 30 minutes or more of moderate-intensity physical activity five days per week, or 20 minutes of vigorous activity three days per week (Pate, Pratt, Blair, Haskell, Macera, Bouchard, Buchner, Ettinger, Heath, King, Kriska, Leon, Marcus, Morris, Paffenbarger Patrick, Pollock, Rippe, Sallis, & Wilmore, 1995). These recommendations were developed after an extensive evidence review involving a committee of experts from America, Canada and the UK.

Several reviews have confirmed that the volume of physical activity is inversely and linearly associated with mortality (such as the Surgeon General's report, US Department of Health & Human Services, 1996; Lee & Skerrett, 2001; Warburton, Nicol & Bredin, 2006). This was apparent for both healthy and clinical adult samples, regardless of demographic differences, and even minimal adherence to current activity recommendations can result in decreased all-cause mortality rates (US Department of Health & Human Services, 1996; Lee & Skerrett, 2001).

Several studies suggest that levels of activity below the recommended levels are still associated with benefit (Kushi, Fee, Folsom, Mink, Anderson & Sellers, 1997; Leon, Connett, Jacobs& Rauramaa, 1987; Paffenbarger, Hyde and Wing, Lee, Jung &

Kampert, 1993). Physical activity has been associated with an improvement in general aspects of positive mood, such as well-being or quality of life, as well as specific measures including anxiety, depression, and stress. The studies within the thesis focus on depression, stress, and anxiety, which are collectively defined as psychological distress.

1.3.1 Depression and Physical Activity

Depression can be defined as feelings of sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness, and poor concentration (World Health Organisation, WHO, 2014). Clinical depression is characterised by the presence of at least five of the following symptoms: depressed mood, loss of interest or pleasure, significant weight loss, weight gain or change in appetite, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue, feelings of worthlessness or excessive or inappropriate guilt, cognitive abnormality, and recurrent thoughts of suicidality persisting over a period of two weeks, for most of the day, nearly every day, where this represents a change compared to previous state (American Psychiatric Association, APA, 2013). The majority of reviews and meta-analyses investigating the effect of physical activity on depression have used self-report instruments to diagnose and assess depression. A recent review reported that only four studies included individuals with depression clinically diagnosed by a health professional in a clinical setting (Krogh, Nordentoft, Sterne & Lawlor, 2011). One of the earliest reviews containing cross-sectional and longitudinal studies found that physical activity improved depression in individuals aged between 11 and 55, with clinical and non-clinical depression (North, McCullagh & Tran, 1990). These findings have been supported by multiple other reviews including those with clinical depression and healthy adults.

Silveira, Moraes, Oliveira, Coutinho, Laks and Deslandes's (2013) meta-analysis (including longitudinal design, randomised and nonrandomised clinical trials) found that physical activity provided moderate benefits as a treatment for depression (defined using a clinical interview schedule; International Classification of Disease 10, WHO, 2014b; Diagnostic and Statistical Manual of Mental Disorders IV, APA

1996; or research diagnostic criteria, resulting in an effect size of smd=0.61). Likewise, Cooney, Dwan, Greig, Lawlor, Rimer, Waugh, McMurdo and Mead's (2013) systematic review included 14 randomised controlled trials including depressed adults who were assessed using any diagnostic method. Cooney et al. (2013) found physical activity was moderately more effective than non-exercising control groups for reducing symptoms of depression (with an effect size g = -0.62). However, the more methodologically robust trials showed a smaller effect in favour of physical activity (similar to Bize, Johnson & Plotnikoff's, 2007, findings with QOL). Cooney et al. (2013) concluded that physical activity appeared to be as effective as psychological or pharmacological therapies, although due to the low number of included studies further research is required to support this conclusion.

A review sampling both healthy adults and individuals experiencing depressive symptoms or clinical depression found an inverse relationship between physical activity and depression (Teychenne, Ball & Salmon, 2008). Teychenne et al.'s (2008) review included 67 studies and spanned across a range of study designs including cross-sectional, longitudinal, randomised and non-randomised controlled trials (which therefore could not calculate an effect size). In samples of healthy adults, Conn's (2010a) meta-analysis (of pre-experimental and experimental design) found that physical activity reduced depressive symptoms. Conn's (2010a) analysis found smaller effect sizes (d=0.37 for supervised exercise interventions and d=0.52 for unsupervised) than in previous studies including clinically diagnosed patients with depression (Lawlor & Hopker, 2001, effect size of d=-1.1 or d=0.66 accounting for methodological weaknesses, Ekkekakis, 2013; Craft & Landers, 1998, g=-0.72; Stanthopoulou, Powers, Berry, Smits & Otto, 2006, d=-1.42), and suggests this is due to a "floor effect" where healthy individuals may have a poorer capacity for improvement than those with clinical depression (Pinquart, Duberstein & Lyness, 2007).

Lawlor and Hopker (2001) criticised previous studies, stating intention-to-treat analysis was underutilised and randomisation concealment and assessment of outcome blinding was poor. In their meta-analysis (limited to RCTs where a participant's depression was defined using the Beck Depression Inventory, BDI, Beck, Ward, Mendelson, Mock & Erbaugh, 1961). Lawlor and Hopker (2001) found that active individuals reported lower depression scores than inactive individuals, and the effect of exercise was similar to cognitive therapy. However, the effectiveness of physical activity in reducing symptoms of depression could not be determined due to the methodological quality of the studies.

A limitation of the majority of reviews and meta-analyses is the use of self-report measures for both physical activity – which can only result in an estimation of physical activity, not an absolute amount – and depression – which are subject to errors in recall, misinterpretation of questions, and social desirability bias. In addition, a concern throughout the literature is that of causation; physical activity may reduce depression, but less depressed individuals may be more inclined to engage in physical activity. One review sought to investigate if psychological therapy for depression improved physical activity levels but found out of 204 RCTs, physical activity was not measured (Cuijpers, de Wit & Taylor, 2014). While cross-sectional studies cannot resolve causal attribution, RCTs are considered a more rigorous method of determining a cause-effect relationship (Sibbald & Roland, 1998). However participants may self-select by not volunteering to be in a physical activity intervention study and through attrition if they are assigned to a disliked condition, resulting in a biased outcome. Non-compliance and attrition are high in RCTs (Nich & Carroll, 2002) therefore it is important to implement intention-to-treat analysis (Armijo-Olivo, Warren& Magee, 2009) which Lawlor and Hopker (2001) found was limited in the evidence. Nevertheless, these reviews suggest that physical activity is involved in the reduction of depression, but further research is required for depression diagnosed by a health professional in a clinical setting to draw adequate conclusions.

Dunn, Trivedi, Kampert, Clark and Chambliss's (2005) experimental study found the optimal dose of physical activity to reduce mild to moderate major depressive disorder was the physiological recommendations stated earlier (Pate et al., 1995), equivalent to thirty minutes of physical activity at least five days of the week. This was supported by Silveira et al. (2013) and Teychenne, Ball and Salmon's (2008) review, which additionally found much lower doses were associated with benefits, including 20 to 60 minutes of physical activity per week (Thirlaway & Benton, 1992; Annesi, Gann & Westcott, 2004). Several reviews do not support an optimal intensity of physical activity, as improvements in depression were found throughout a range of intensities (Teychenne, Ball & Salmon 2008; Paluska & Schwenk, 2000; Craft & Perna, 2004). In addition, there may not be an optimal type of physical activity to improve depression. Lawlor and Hopker (2001) found no difference between endurance and resistance exercise and Conn (2010a) suggests aerobic fitness may not be the mechanism which reduces depression. An early experimental study found no difference in the improvement of depression between aerobic (running) and nonaerobic (weight training) exercise (Ossip-Klein, Doyne, Bowman, Osborn, Mcdougal-Wilson and Neimeyer, 1989).

1.3.2 Anxiety and Physical Activity

While anxiety has been studied less frequently than depression (Strohle, 2009) there are still a number of reviews establishing the link between anxiety and physical activity. Anxiety can be defined as an emotional response to either objective or subjective stressors that results in a combination of feelings, cognitions and physiological changes (Spielberger, 1972). Anxiety has been conceptualised as either state anxiety (which is a transient condition lasting a small timespan of a few minutes or seconds), or as trait anxiety (a relatively stable personality trait, Spielberger, 1972). Trait anxiety is often associated with feelings of apprehension, tension, and increased activity of the autonomic nervous system (Spielberger, 1972). Raglin (1997) states that the majority of physical activity research has examined the concepts of state and trait anxiety separately. Studies investigating state anxiety have usually examined acute exercise or single sessions of physical activity whereas studies investigating trait anxiety have focused on chronic physical activity programmes.

Petruzzello et al. (1991) conducted one of the most comprehensive meta-analyses in the field of physical activity and anxiety (Biddle & Mutrie, 2008). Petruzzello et al. (1991) concluded that physical activity was related to reduced anxiety from an investigation of 104 studies featuring varying methodological designs with samples ranging from healthy individuals and patients with high and low anxiety, to individuals recruited from cardiac rehabilitation and weight control programmes. Petruzzello et al. (1991) found a significant overall effect size of exercise for both state (g=0.24) and trait (g=0.34) anxiety. State anxiety improved with both chronic and acute physical activity, and trait anxiety improved with chronic physical activity. No studies measured trait anxiety and acute physical activity, therefore no conclusion could be drawn. Overall, physical activity was found to be as effective as anxiety-reducing treatments (for example, relaxation or meditation).

In support of Petruzzello et al.'s (1991) findings, Long and van Stavel's (1995) meta-analysis found that physical activity resulted in significant reductions in both trait and state anxiety (with an overall effect size of g=0.45 within-group pre-post studies, and g=0.36 for contrast group studies), but was particularly effective for adults who have elevated levels of stress. Long and van Stavel (1995)excluded acute physical activity and limited their analysis to physical activity interventions that occurred for least six weeks, for a minimum of twice a week (nonaerobic exercise) or three times a week (aerobic exercise) for at least 20 minutes. Anxiety was defined through self-report measures, and included clinical and nonclinical populations and experimental or quasi-experimental study design.

Wipfli, Rethorst and Landers (2009) also included clinical and non-clinical samples of adults with varying ages and limited their meta-analysis to RCTs. Wipfli et al. (2009) found that exercise was superior to non-exercise control groups in the reduction of anxiety (with an effect size of g= -0.48), was comparable to psychotherapy, and was significantly better at reducing anxiety than other forms of treatment (such as group therapy, relaxation/meditation, and stress management education), except pharmacotherapy.

Herring et al. (2010) limited their meta-analysis to clinical samples including sedentary individuals with chronic illness with anxiety, and excluded non-randomised trials. Herring et al. (2010) found that compared with no treatment conditions, physical activity significantly decreased anxiety among patients with a chronic illness. However, the effect size (Δ = 0.29) was smaller than in other meta-analyses (Long & van Stavel, 1995; Petruzzello et al., 1991; Wipfli, Rethorst & Landers, 2009).

Conn (2010b) limited their meta-analysis to healthy adults and included randomised and non-randomised experimental studies. Studies were excluded if participants were diagnosed with anxiety disorders or indicated significant anxiety on self-report anxiety measures. The analysis focused on chronic physical activity and excluded acute. Conn (2010b) found that physical activity interventions decreased anxiety in healthy adults. As with Herring et al.'s (2010) review, the effect size (d = 0.22) was less than that found in Long and van Stavel (1995), Petruzzello et al. (1991), and Wipfli, et al. (2009). Conn suggests that the anxiolytic effects of physical activity may be more pronounced in more anxious individuals (Salmon, 2001), similar to the "floor effect" found with depression.

The findings from Petruzzello et al. (1991) suggest that the optimal dose of physical activity to reduce state anxiety includes at least 20 minutes of aerobic physical activity. No difference in effectiveness was found between acute and chronic physical activity, length of programme, or intensity. Frequency was not included in meta-analysis calculations. The optimal dose of physical activity to reduce trait anxiety varies throughout meta-analyses. The most effective duration of physical activity per session was at least 20 minutes (Petruzzello et al., 1991) or at least 30 minutes (Herring et al., 2010). Petruzzello et al. (1991) recommended a programme length of at least 10 weeks, whereas Herring et al. (2010) found programmes of 3 to 12 weeks more effective than programmes exceeding 12 weeks. However, Herring et al. (2010) suggest their findings may be related to increased adherence to the shorter intervention. Conn's (2010b) analysis including healthy adults found that the duration of physical activity, per session and as a programme, made no impact on the effectiveness of physical activity in reducing anxiety. Petruzzello et al. (1991) did not include frequency in their meta-analysis calculations. However Herring, et al.'s (2010) findings suggest engaging in physical activity three to five times per week is more effective than once, twice or four times per week. There was no difference in effectiveness between aerobic and non aerobic exercise (Petruzzello et al., 1991) or between aerobic and resistance training (Herring et al., 2010). Herring et al. (2010)

and Conn (2010b) found moderate and vigorous intensity activity was more effective than low intensity physical activity.

Both Petruzzello et al.’s (1991) and Herring et al.’s (2010) findings suggest a dose of 20 to 30 minutes per session, at least three times per week, of moderate intensity physical activity to achieve anti-anxiety effects, similar to that of recommended physiological physical activity doses (Pate et al., 1995). However, Wipfli et al. (2009) found the benefits of physical activity on anxiety may be achievable with a lower dose. Wipfli et al. (2009) estimated the optimal dose of physical activity in units of energy expended during exercise (12.5 kcal/kg/week) which was below the optimal dose prescribed by Dunn et al. (2005) and the physical recommendation defined by Pate et al. (1995).

1.3.3 Stress and Physical Activty

There are fewer reviews and analyses investigating the link between stress and physical activity than for anxiety and depression. Stress is often included in analyses examining anxiety; for example, Long and van Stavel’s (1995) and Wipfli et al.’s (2009) analyses included stress management education as a comparative condition to physical activity. Long and van Stavel's (1995) analysis included stress as an important variable, as one of their research questions addressed the effectiveness of physical activity in treating individuals who were experiencing stress versus those who were not. Few reviews have examined stress singularly; these include Crews and Landers (1987), Taylor (2000), Salmon (2001) and Scully et al. (1998).

Stress has been defined as a perceived inadequacy to cope with demands of life or threats to an individual’s well being (Lazarus, 1966). Long and van Stavel (1995) explained stress as a process where stressors are appraised as exceeding one’s coping ability, differentiated from anxiety, which was defined as an emotional response to stressors perceived as threatening or harmful to well-being (Lazarus & Folkman, 1984).

An early meta-analysis found overall aerobically fit individualshad a greater reduced stress response than unfit individuals (Crews & Landers, 1987, effect size g=0.48), but results were inconsistent. Scully et al.'s (1998) more recent narrative review reported that the majority of studies find physical fitness correlates with a reduction in the physiological response to psychological stress. However there was ambiguity in relation to the influence of aerobic exercise on the stress response. Taylor's (2000) review found three quarters of studies showed a positive effect on reactivity to recovery from a psychosocial stressor after a single bout of physical activity, but the outcomes from chronic physical activity were mixed. Approximately half of the studies found a positive effect on psychosocial and physiological measures after chronic exercise training, the other half found no effect.

Studies included in these reviews measured the stress response using a range of tests including timed cognitive tasks, passive response tasks (watching videos of industrial accidents and medical procedures), active physical performance tasks (such as exercise) and passive physical performance tasks (immersing a limb in ice water). Fitness was defined using a range of physiological measures (such as heart rate, blood pressure, hormonal changes) and subjective assessment. Salmon (2001) suggested that the more negative outcomes are due to attempts to contrast physiological responses to mental arithmetic or psychomotor tasks between fit and unfit individuals from the general population. Significant contrasts were more likely to occur: when more subtle measures of cardiovascular function were used to indicate sympathetic activity; when highly fit individuals were compared to highly sedentary ones; and when samples were selected from populations that demonstrated increased cardiovascular lability in response to psychological stress (Salmon, 2001). Long and van Stavel's (1995) analysis found that individuals with a more stressful lifestyle benefited more from physical activity than those who were less stressed. This may be related the "floor effect" previously described in relation to anxiety and depression.

Within the studies, Salmon (2001) suggests that stressors have been seen as interchangeable. However, different demands have different physiological effects. Tasks which require effortful coping strategies may stimulate noradrenergic responses, but tasks which include novelty, lack of control or the need for adaptation (i.e. allostasis) may stimulate the pituitary-adrenal system (Steptoe, 1983).

Salmon (2001) argues that physical activity has not been tested in relation to these specific systems, and there has been an over-reliance on using cardiovascular responses to measure stress. In addition, the poor ecological validity of laboratory based stressors means that they are not good comparisons to real life experience. Salmon (2001) argues that it is difficult to establish a causal link between stress and physical activity. Individuals who habitually engage in physical activity report less stressful lives (Norris, Carroll & Cochrane, 1992), which may be due to a stress protective element of exercise or may be because less stressed individuals are more willing to engage in physical activity. However, there have been several physical activity interventions that have been found to reduce life stressors (Cramer, Nieman, & Lee, 1991) and protect against psychological distress and impaired immune system after HIV diagnosis (LaPerriere, Antoni, Schneiderman, Ironson, Klimas, Caralis & Fletcher, 1990).

Due to the lack of consistency, there is little evidence representing an optimal dose of physical activity to enhance stress responsivity. Berger (1986) and Berger and Owen (1983) suggest a duration of 20 to 30 minutes of physical activity. This is also supported by Scully et al. (1998) who recommend at least 21 minutes per session, with an intensity to elevate heart rate significantly above resting pulse. Carmack and Martens (1979) and Mandell (1979) suggest that an exercise duration of 60 minutes may result in even more psychological benefit.

1.4 **Mechanisms of Physical Activity in Improving Psychological Distress**

1.4.1 Physiological Mechanisms

Strohle (2009) suggests that the mood-enhancing effect of physical activity is likely to include a complex interaction of psychological and neurobiological mechanisms. The neurobiological mechanisms of physical activity on depression and anxiety are not well understood (Arent, Landers & Etnier, 2000; Daley, 2008; Deslandes, Moraes, Ferreira, Veiga, Silveira, Mouta, Pompeu, Silva Freire Coutinho & Laks, 2009), therefore a number of theories have been proposed. The endorphin hypothesis

(Steinberg & Sykes, 1985), suggests physical activity improves mood and feelings of well-being through the release of endogenous opiates. However, more recent evidence suggests that the analgesic effect of physical activity, associated with sedation, anxiolysis and well-being, is related to activation of the endocannabinoid system (Sparling, Giuffrida, Piomelli, Rosskopf & Dietrich, 2003; Dietrich & McDaniel, 2004). The monoamine hypothesis (Pierce, Kuppart, & Harry, 1979) suggests that physical activity may increase the availability of neurotransmitters such as serotonin, noradrenaline and dopamine (Deslandes et al., 2009), the dysregulation of which has been associated with depression (Delgado, 2000; Delgado & Moreno, 2000; Hirschfeld, 2000).

In relation to improving brain health and potentially improving depression, Cotman, Berchtold and Christie's (2007) review suggested that physical activity may modulate a range of systems involved in brain maintenance and plasticity, including neurogenesis, enhanced central nervous system metabolism, and angiogenesis. This may lead to increased energy demands of the brain, triggering increased enzymes involved in glucose use and metabolism in the hippocampus (Ding, Vaynman, Souda, Whitelegge & Gomez-Pinilla, 2006; Tong, Shen, Perreau, Balazs, & Cotman, 2001), and widespread growth of blood vessels in the hippocampus (van Praag, Schinder, Christie, Toni, Palmer, & Gage, 2005), cortex (Ding, Li, Zhou, Rafols, Clark, & Ding, 2006) and cerebellum (Black, Isaacs, Anderson, Alcantara, & Greenough,1990).

Dysfunction of the hypothalamic-pituitary-adrenocortical (HPA) axis has been implicated in mood disorders (Watson & Mackin, 2006) including depression (Murri, Pariante, Mondelli, Masotti, Atti, Mellacqua, Antonioli, Ghio, Menchetti, Zanetidou, Innamorati & Amore, 2013), anxiety (Faravelli, Lo Sauro, Lelli, Pietrini, Lazzeretti, Godini, Benni, Fioravanti, Talamba, Castellini & Ricca, 2012), and stress (Miller, Chen & Zhou, 2007). In brief, the activation of the HPA axis by stressors produces elevations of cortisol, adrenocorticotropic hormone, and corticosteroids (Nabkasorn, Miyai, Sootmongkol, Junprasert, Yamamoto, Arita & Miyashita, 2005). Brosse, Sheets, Lett, and Blumenthal (2002) suggest that over time physical activity can attenuate the HPA axis response to stressors, thus providing a protective effect and promoting psychological well-being.

In the reduction of anxiety, low intensity and high intensity physical activities may activate different mechanisms. Low intensity activity (for example, yoga) may induce body awareness (Lidor, 1999, p. 109) and mindfulness, which can promote a positive affect (Netz & Lidor, 2003). Mindfulness may inhibit the impact of stressors activating the HPA axis response (Rosenzweig, Reibel, Greeson, Brainard, & Hojat, 2003) and induce low-level physiological arousal (Benson & Klipper, 1975). Greater intensity activities may activate the endocannabinoid system, as mentioned earlier (Sparling, Giuffrida, Piomelli, 2003), which may alter emotional and cognitive processes, induce sedation (Chaperon & Thiebot, 1999) and reduce anxiety (Deitrich & McDaniel, 2004).

1.4.2 Psychosocial Mechanisms

Psychosocial mechanisms include the promotion of self-efficacy and self-esteem (Fox, 1999; Taylor & Fox, 2005), sense of mastery (Bandura, 1986), and distraction from negative affect (Bahrke & Morgan, 1978). These mechanisms may be enhanced by a socially minded instructor and group dynamic, to boost satisfaction and enjoyment (Rejeski & Mihalko, 2001).

The self-efficacy theory (Bandura, 1997) suggests that an individual's confidence to engage in physical activity is strongly related to their ability to perform the behaviour. Successful engagement may lead to improvements in mood, confidence, and self-efficacy, which may impact on personal autonomy and ability to cope with life (Craft, 2005; Faulkner & Carless, 2003; Paluska & Schwenk, 2000; McAuley & Courneya, 1992; McAuley, Shaffer, & Rudolph, 1995; Mihalko & McAuley, 1996). Evidence has been found for a negative correlation between depression and self-efficacy in a university sample of mild to moderately depressed women (Chu, Buckworth, Kirby & Emery, 2009) and in working age depressed women (Craft 2005). Bodin and Martinsen (2004) compared two different types of physical activity designed to represent an activity that required learning and remembering that would boost self-efficacy (martial arts) and an activity related only to physical functioning (stationary cycling). Participants in the martial arts group reported significant increases in positive affect, reductions in negative affect and state anxiety, and increased self-efficacy. However, there were no significant changes for those allocated to the stationary bike exercise condition. Bodin and Martinsen (2004) concluded that increased self-efficacy may be required for mood benefits to occur.

The Exercise and Self- Esteem Model (EXSEM, Sonstroem & Morgan 1989; and updated by Sonstroem, Harlow & Josephs, 1994) proposes that self-efficacy operates as moderator between physical activity and perceptions of the physical self (relating to sports competence, physical condition). Perceptions of the physical self generalise to overall sense of physical self worth, which then generalises to global self-esteem. Ryan (2008) argues low global self-esteem can manifest as negative self-attitudes, which is a prominent symptom of depression (American Psychiatric Association, 1994) and therefore suggests that increasing physical activity can increase self-esteem, providing an anti-depressant effect. The model was supported by cross-sectional evidence in healthy adults and breast cancer survivors (Sonstroem et al., 1994; Baldwin & Courneya, 1997), and longitudinal evidence in older adults (Li, Harmer, Chaumeton, Duncan, and Duncan, 2002; McAuley, 2000; 2005). Van de Vliet, Knapen, Onghena, Fox, David, Morres, Coppenolle and Pieters (2002) compared the model between psychiatric in-patients with mood disorders and non-patients, and found psychiatric patients had significantly lower physical and global self-perceptions than non-patients. Van de Vliet et al. (2002) state this is consistent with the findings that clinical depression is associated with low levels of self-esteem (Ossip-Klein et al., 1989; Wilson & Krane, 1980). In addition, Van de Vliet et al. (2002) confirmed the relationship between physical self-perceptions and negative affective states was mediated by global self-esteem. However, Ryan (2008) argues the focus on global self-esteem as the most general outcome of physical activity offers an incomplete explanation of activity-based antidepressant effect. Ryan (2008) argues it is not clear whether the exercise effects on global self-esteem are large enough to explain the observed antidepressant effects of aerobic exercise. For example, Spence, McGannon, and Poon’s (2005) meta-analysis found the average effect size in activity and self-esteem studies was relatively small (d=0.23) which suggests changes in self-esteem may not be capable of producing a sufficient magnitude of antidepressant effect to be of clinical benefit (Ryan, 2008).

The self-efficacy theory links with the mastery hypothesis (Greist, Klein, Eischens, Faris, Gurman & Morgan, 1979), which suggests that overcoming a challenging physical activity related task may improve skill acquisition and development (Simons, Epstein, McGowan and Kupfer, 1985). This development may transpose onto everyday tasks, increasing independence, success and a sense of control, which may improve mental health and well-being. For example, Greist (1984) found exercise and relaxation conditioning were superior in reducing depression after a three-month follow up compared to psychotherapy. Simons, Epstein, McGowan and Kupfer (1985) suggest that patients in relaxation and exercise groups learned new, practical skills which they were able to continue performing when treatment was terminated. Biddle and Mutrie (2007) suggest that depression is the result of believing no action can alleviate the problem, but that this learned helplessness can be alleviated by using exercise to gain control of the physical self. Ransforn (1982) suggests that even non-aerobic and non strenuous activity (such as golf and bowling) also improve self-efficacy and suggest this is because these activities provide opportunities for improvement and accomplishment. Using a Canadian population study, Martin and Wade (2000) examined the relationships between distress (measuring hopelessness, worthlessness, sadness, and nervousness) and self-esteem, mastery, and social support. They found physical activity was independent of stress, self-esteem and social support, but that mastery both mediated and moderated the relation of physical activity with distress. They suggest physical activity may increase a sense of mastery or control, which acts as a protective mechanism against distress (Pearlin, Lieberman, Menaghan & Mullan, 1981; Pearlin & Schooler, 1978).

Wassink-Vossen, Collard, Oude Voshaar, Comijs, de Vocht, and Naarding (2014) compared physical activity in older adults with and without depression and found those who were depressed exhibited lower levels of physical activity and sense of mastery than their non-depressed counterparts. On further examination, a lower sense of mastery and greater functional limitations were the most important contributors to physical activity behaviour. Wassink-Vossen et al. (2014) concluded that psychotherapeutic interventions should seek to strengthen the sense of mastery, as well as to provide support to cope with functional limitations. Craft (2005) facilitated a mastery experience in a nine week exercise intervention (for example, participants were trained how to monitor their heart rates and regulate the intensity of the exercise session) for clinically depressed adult women. Craft (2005) considered mastery as a derivative of self-efficacy and reported self-efficacy significantly increased throughout the intervention, which was also related to improvements in depression. Thus recommending mastery and therefore self-efficacy should be an important component in the treatment of depression.

The distraction hypothesis (Bahrke & Morgan, 1978) suggests that physical activity can provide time away from daily life and stress, which may also offer an explanation for why low intensity activities described by Ransform (1982) are successful. Distracting activities have shown a more positive influence on the management of depression and reduction of symptoms than self-focused introspective activities, such as keeping a journal, or identifying adjectives to describe an individual’s current mood (Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1989). Paluska and Schwenk (2000) suggest that acute physical activity (for example, a single bout) may improve affect due to this mechanism. Craft (2005) compared depressed women exercising in a group with those exercising alone (who chose their own physical activity type and prescription) and found that depression fell from moderate to minimal for those in the group exercise condition. Craft (2005) hypothesised that rumination and distraction would be significantly correlated with depression, however this was not supported. As depression did reduce in the exercise group, Craft (2005) concludes that rumination or distraction was not the psychological mechanism explaining the antidepressant effects of exercise.

Social physical activity may interrupt social isolation, thus breaking a pattern of social withdrawal and inaction; an action which is critical to therapeutic improvement (Barlow, Allen & Choate, 2004; Dimidjian, Hollon, Dobson, Schmaling, Kohlenberg, Addis, Gallo, McGlinchey, Markley, Gollan, Atkins, Dunner & Jacobson 2006; Hopko, Lejuez, Ruggiero & Eifert, 2003). Nolen-

Hoeksema (1991) suggests social support may mediate the relationship between rumination and depression (provided the social support encourages the individual to stop ruminating and start engaging in distracting activities). As all participants in Craft's (2005) study reported a reduction in rumination, Craft suggested that members of the exercise group provided social support (as described by Nolen-Hoeksema (1991) which may have attenuated the effects of rumination on depression. However, even participants who were exercising alone reduced their levels of rumination, which could not be attributed to social support from an exercise group, thus supporting either alternative psychological mechanisms or an interaction to understand the therapeutic effect of physical activity.

The social interaction hypothesis suggests that psychological well-being and mental health is improved by social relationships, interaction and support from others in a physical activity setting (Randford, 1982). Biddle and Mutrie (2001) suggest socially excluded groups, such as those with depression, may benefit especially from social physical activity. Garmendia, Dangour, Albala, Eguiguren, Allen and Uauy (2013) examined adherence to physical activity interventions in older adults through qualitative analysis. They found an important facilitator of adherence was the opportunity for social interaction through exercise classes and for becoming part of a peer group. Social reinforcement may contribute to adherence and the therapeutic effect from fellow exercisers or through social support from family and friends (Blumenthal et al., 2007; Spirduso, Francis& MacRae, 2005). However, Spirduso, Francis and MacRae (2005) note that the optimal degree of social interaction is subjective to the individual: coercing individuals to engage with others when they do not desire much social interaction may not be as beneficial to their health. Social support can be conceptualised as perceptions of "group cohesion" (Duncan, Mauley, Stoolmiller & Duncan 1993; Courneya & McAuley, 1995; Kwak, Kremers, Walsh & Brug, 2005). Festinger et al (1950) described cohesion as the forces which influence members to remain in a group. A meta-analysis by Carron, Hausenblas, and Mack (1996) found that increased group cohesion was related to increased adherence. They reported that engaging in physical activity with others has a small to moderate effect on adherence behaviour and that the effect increased to moderate to large when individuals participated in cohesive groups.

An individual may be more motivated to engage in physical activity if it provides an opportunity for social interaction, also known as 'relatedness'. Self-Deterministic Theory (SDT), (Ryan, Williams, Patrick, & Deci, 2009) posits that the motives an individual has for an activity are related to how well they will satisfy three psychological needs, including autonomy (a desire to be self-initiating in the regulation of personal behaviour), competence (a desire to interact effectively within the environment), and relatedness (a desire to feel connected to others). While relatedness directly applies to social environments or relationships, autonomy and competence are experiences that can also be readily affected by conditions in the social environment. For example, an activity may be high in intrinsic motivation, and therefore highly interesting to an individual but a controlling coach who pressures may diminish this interest and joy of engagement. Similarly, non-optimal conditions and overwhelming challenges can lead to feelings of incompetence and disengagement.

1.4.3 Qualitatitive Contributions

The qualitative literature suggests that the mechanisms may be more wide ranging than the factors previously described. For example, physical activity has the potential to change a person's identity, relationship with others and their social role. Mason and Holt (2012) conducted a review of qualitative studies investigating how physical activity may result in a therapeutic change for individuals with psychological distress. After examining thirteen studies, the authors identified six themes.

One theme included improved symptoms which may have been related to the distraction hypothesis mentioned earlier, where participants felt time exercising was time away from thinking about their mental health, but also contributed to better sleep, improved mood and concentration. One of the most important themes was that exercise provided an opportunity for social interaction and social support. Over half the studies explicitly reported the importance of social interaction and inclusion as part of their involvement in physical activity. Benefits reported included the opportunity to meet and be with others (Crone, 2007) and a meaningful opportunity for social interaction (Caret-Morris & Faulkners, 2003) especially for those with clinical diagnoses. Faulkner and Biddle (2004) found for a participant who was a "slow starter" physical activity normalised and promoted social interaction. Crone and Guy (2008) found opportunities for social interaction led to greater confidence, and that it was easier for participants to socialise with others in the same situation, where the pressures were different from other social situations. Carless and Douglass (2008) identified a relationship narrative where the main motivation to engage in the exercise program was to share their experience with others.

A third theme was how physical activity provided a sense of meaning, purpose and achievement. This relates to the self-efficacy hypothesis, where participants felt physical activity provided an intrinsic sense of reward and achievement through purposive activity. A fourth theme was the role of facilitating personnel. Supportive phone calls from staff promoted attendance (Carless & Douglass, 2004) and staff were also able to promote esteem (Carless & Douglass, 2008) which promoted a sense of competence, confidence, as well as pleasure and pride. The fifth theme was feeling safe, where being in a group of other exercisers (where participants had the same illness) allowed participants felt accepted and secure. This offset the fear of stigma of attending a community gym. Carless and Douglass (2004) and Raine et al. (2002) highlighted the importance of non-competitive and caring environment which enabled shared talk of experiences of mental illness and treatment. The final theme was identity, where participants were able to change their identity from "someone with a mental illness" to something more positive. The authors suggest this concept is probably related to the self-esteem variables previously mentioned.

These themes underline and support the previous factors and hypotheses to suggest how psychical activity may facilitate therapeutic change. However these findings also expand upon how improvements in classic psychological factors can lead to a sense of fulfilment, engagement and self-acceptance which may improve psychological distress but is unlikely to be measured or measured easily in quantitative studies. Importantly this review highlights the importance of social interaction for the promotion of well-being. Some participants reported that they attended simply to engage with others, rather than focusing on the physiological improving aspects of exercise. The authors of the review state that improved symptoms only formed one area of impact, and highlight the importance of positive social interaction and relationships, a sense of meaning, purpose and achievement opportunity that participation in physical activity. The participants of group physical activity may have been able to model the relationships that can develop with facilitators and participants and generalise them to other aspects of their lives, thus promoting more and richer social contact and promoting wellbeing. The authors state that whatever the activity-based intervention provided, it was the relationships and the participant's place in the group that was important to the changes in them that took place.

Nevertheless, solo physical activity has been found to promote psychological wellbeing, so combinations of all the mehcanisnms described may contribute to the therapeutic effect of physical activity including both biochemical and psychosocial mechanisms (Biddle & Mutrie, 2001). In addition, the added element of social interaction, support and instruction from engaging in group physical activity may enhance or support the development of self-efficacy, mastery, and distraction from negative affect. In addition, social support may also contribute to the neurobiological mechanisms involved in promoting psychological well-being. For example, social support has been associated with a reduced neuroendocrine reactivity to social stressors (Eisenberger, Taylor, Gable, Clayton, Hilmert & Lieberman, 2007), which may additionally support the protective effect of physical activity on the HPA axis response. Recently, Lehnert, Sudeck, & Conzelmann **(**2012) report there has been little development in the psychological approaches since 1991 (Biddle & Mutrie, 1991) and while evidence confirms the therapeutic effect of physical activity, very little is understood about the underlying mechanisms, warranting further investigation (Stathopoulou, Powers, Berry, Smits, & Otto, 2006).

1.5 **Effectiveness of Group versus Solo Physical Activity in reducing Psychological Distress**

This thesis aims to investigate the relationships between both group and solo physical activity and psychological distress. While a number of studies have compared the effectiveness of group versus solo physical activity contexts in improving psychological distress, only one meta-analysis has evaluated these studies. Burke et al. (2006) compared the contexts of home-based programmes with and without contact, standard exercise classes, and/or true groups (defined as employing team building exercises to encourage cohesion) in relation to adherence, social interaction, quality of life, physiological effectiveness, and functional effectiveness. The quality of life category included a variety of scales measuring depression, anxiety, stress, behavioural or emotional control, psychological well-being, and other measures of physical functioning which included psychological well-being related items. Burke et al. (2006) found virtually no differences between the collective and home-based with contact conditions, but did find the collective condition was superior to the home-based no contact condition, although differences were not significant.

A limitation of Burke et al.'s (2006) review was the absence of analysis of separate quality of life components (such as depression or anxiety), when it is possible these components may interact with group and solo physical activity contexts differently. This area requires further review, to establish the relationship between depression, stress and anxiety, and group and solo physical activity. In addition, the majority of studies measuring quality of life featured individuals with chronic illness. Only one included healthy adults, who were aged between 50 and 65 years (King, Taylor, & Haskell, 1993) and this found that group and solo physical activity were equally effective in reducing psychological distress. Studies conducted after 2006 investigating group versus solo physical activity in the reduction of psychological distress continue to include adults with chronic illness. Since 2006, one study has investigated healthy men aged between 18 and 40 years (McGale, McArdle, & Gaffney, 2011). McGale, McArdle, and Gaffney (2011) found that depression improved within group and solo physical activity conditions, and that both physical activity conditions were equally effective in reducing depression. Further research is required to examine the relationship between psychological distress and group and solo physical activity within the general adult population, including younger adults and factors associated with participation.

1.6 **Current Engagement with Physical Activity**

As previously mentioned, the recommended dose of physical activity for physiological benefits includes an accumulation of 30 minutes or more of moderate-intensity physical activity five days per week, or 20 minutes of vigorous activity three days per week (Pate et al., 1995), similar to recommendations for improved depression and anxiety.

Despite the benefits associated with physical activity, UK population engagement is poor. Self-report surveys find averages of 61.5% of men and 71.5% of women do not meet physical activity recommendations. Scotland represented the most active, with 45% of men and 33% of women engaging in recommended levels of physical activity. This was followed by England, including 39% of men and 29% of women, Wales including 37% of men and 24% of women, Northern Ireland, including 33% of men and 28% of women meeting physical activity recommendations (The British Heart Foundation, 2012; Joint Health Surveys Unit, 2010; Scottish Health Executive, 2011; Welsh Government, 2011; Northern Ireland Statistics and Research Agency, 2007).

Recently, the World Health Organisation (WHO, 2010) updated physical activity recommendations and suggested that individuals should be active daily, engage in moderate physical activity for a minimum of 150 minutes per week (accumulated in bouts of at least 10 minutes per session), or engage in 75 minutes of vigorous activity per week (or a combination of vigorous and moderate), engage in activities that strengthen muscles at least twice per week and limit extended periods of sedentary activity. These recommendations were based on an updated review of the literature (U.S. Department of Health and Human Services, 2008) and do not negate the 1995 recommendations (Oja & Titze, 2011). Although there are differences in daily versus weekly recommendations, the new recommendations advise distributing acitivity throughout the week.

A recent survey (The Scottish Health Survey, 2012) interviewed 4,815 members of the Scottish population and found 62% of adults (including 67% of men and 58% of women) met physical activity recommended levels. Similarly, 14% of men and 19%

of women were categorised as engaging in low levels of physical activity (30 to 60 minutes of moderate physical activity or 15 to 37.5 minutes of vigorous physical activity per week). The remaining percentages of individuals engaged in very low levels of physical activity (under 30 minutes of moderate physical activity or under 15 minutes of vigorous activity per week) including 19% of men and 23% of women. The SHS (2012) suggested the differences in physical activity levels from 2010 may be due to a change in questionnaire structure. To meet physical activity recommendations, participants were not required to engage in moderate physical activity 5 days per week or vigorous on 3 (as prescribed previously), but were allowed to accumulate 150 minutes of moderate intensity, or 75 minutes of vigorous intensity physical activity over a week (as per recent recommendations from the WHO, 2010). In addition, 40 different sporting activities were included to provide participants with a recall prompt. While authors suggest that surveys from 2010 and 2012 are not directly comparable for this reason, they suggest that the impact is relatively small. Surveys from both 2010 and 2012 show an increase of physical activity from the SHS conducted in 2006, which found 65% of individuals did not meet recommendations, with 27% engaging in physical activity just once or twice a week, 7% once or twice a month, 9% less often than once a month and 22% not engaging at all. Increasing awareness of the benefits of physical activity may have contributed to a genuine increase in physical activity levels, but may have also introduced social desirability bias, which may be more pronounced when being interviewed, introducing interviewer bias (Roberts, 2010). While data were provided on sporting activities, it was difficult to examine a comparison between group and solo contexts. In addition, ambiguous activities such as aerobics, weight training, walking or jogging were reported, but no social context was provided.

University students, who may be perceived as having greater flexibility in relation to time and greater access to a range of sports and exercise facilities than full-time employed adults, also demonstrate poor adherence to physical activity recommendations. The National Active Student Survey (NASS, British Universities and College Sport and Leisure-net Solutions, 2007) found, from a sample of 22,000 students from 110 UK institutions through self-report, that only 23% reached physical activity recommendations. 48% of students engaged in three 30 minute sessions of moderate intensity activity per week, and the remaining 29% engaged in less per week. These figures would be likely to be improved if physical activity recommendations were defined under new WHO guidance.

In addition, university students and young adults in general are an important population to target, as physical activity levels appear to drop when individuals leave school. Bauman, Owen, and Rushworth (1990) found that leisure time inactivity was twice as high for those aged 20 to 29 than for individuals under 20. Likewise, Owen and Bauman (1992) found significantly higher rates of inactivity for 25 to 29 year olds compared to those under 25. A greater percentage of high school students engage in regular vigorous activity (63.7%) than university students (37.6%; U. S. Department of Health and Human Services, 1996; Douglas, Collins, Warren, Kann, Gold, Clayton, Ross & Kolbe, 1997). This may be related to leaving an environment that facilitates physical activity and moving from one life stage to another (Calfas, Sallis, Lovato, Campbell, 1994).

These studies used questionnaires to estimate physical activity, and are popular due to their low cost, practicality, low participant burden and general acceptance (Dishman, Washburn, & Schoeller, 2001). Self-report questionnaires avoid the problem of interviewer bias (Kohl, Blair, Paffenberger, Macera & Kronenfeld, 1988), interference with usual activity found with logs and records, and the increase physical activity due to observation effects (Dishman, Washburn, & Schoeller, 2001). However, physical activity may be over-estimated due to recall error (Prince, Adamo, Hamel, Hardt, Gorber & Tremblay, 2008). For example, a sedentary individual or someone with a routine may more accurately remember their activities more so than someone who is sporadically active (Dishman, Washburn, & Schoeller, 2001). In addition, the estimated duration of an activity may be exaggerated due to the inclusion of time spent changing and socialising, and for refreshment (Shepard, 1967). As previously mentioned, physical activity may also be over-estimated due to social desirability bias: when an individual wishes to portray themselves favourably to others (Warnecke, Johnson, Chavez, Sudman, O'Rourke, Lacey, & Horm, 1997). In addition, individuals may seek social approval, or the need to obtain a positive response in a testing situation (Hebert, Clemow, Pbert, Ockene & Ockene, 1995).

Finally, studies may be influenced by the rate of nonresponse in mail surveys (Kohl, Blair, Paffenbarger, Macera & Kronenfeld, 1988). Despite these issues, questionnaires have been found to be accurate for ranking large groups of people according to level of physical activity (Dishman, Washburn, & Schoeller, 2001) and providing some basic quantification of the major behavioural characteristics of physical activity patterns (Matthews, 2002).

As previously mentioned, inactive individuals benefit the most, both physiologically and psychologically, from increasing their physical activity level (Pate et al., 1995; Lee & Skerrett, 2001; Kushi, Fee and Folsom, 1997; Leon, Connett & Jacobs, 1987; Paffenbarger, Hyde & Wing, 1993), making them an important target population for physical activity interventions. Likewise, university students are important to investigate, with the aim of promoting physical activity engagement throughout adult life.

1.6.1 Factors Associated with Physical Activity Engagement

The most effective interventions alter the underlying variables that influence physical activity (Trost, Owen, Bauman, Sallis & Brown, 2002). Therefore, studying determinants or correlates of physical activity is an important prerequisite for developing policies and effective programmes. Trost et al. (2002) conducted a systematic review including over 330 studies, compiling 75 correlates of physical activity from demographic, psychological, cognitive, and emotional factors, behavioural attributes and skills, social and cultural factors, environmental, and physical activity programme determinants.

Age, being male, barriers to physical activity, lack of time, mood disturbance, climate/season and perceived effort were the most consistent inverse correlates of physical activity engagement. Socioeconomic status, including occupational status and educational attainment, enjoyment of physical activity, expected benefits, intention to exercise, perceived health or fitness, self-efficacy, self-motivation, self-schemata for exercise, stage of change, physician influence, social support from friends/peers and spouse/family were the most consistent positive correlates of physical activity.

Trost et al.'s (2002) review was an update to Sallis and Owen's (1999) review, which offered a comparison between supervised studies (where physical activity had been prescribed as part of an intervention study) or community-based (where physical activity levels were assessed overall, including all settings, such as including leisure time activity or travel to work) and found some differences in consistency across correlates. For example, their findings suggest that in naturalistic settings (as in community-based studies) demographic factors, barriers to exercise, enjoyment of exercise, expected benefits, intention to exercise, mood disturbance, psychological health, dietary habits, social support from friends/peers, climate/season and perceived effort of physical activity are more consistent correlates than in studies that prescribe physical activity.

The most consistent correlates found through intervention studies were blue-collar occupation, lack of time, self-efficacy, self-motivation, activity history during adulthood, past exercise programme, smoking, social support from spouse/family, intensity and perceived effort of physical activity programme. This suggests that there may be different issues for participants engaging in physical activity intervention studies, which may impact the efficacy of physical activity intervention development and promotions. In addition, while these correlates may apply differently to participants engaging in group and solo physical activity interventions, no distinction was made between these contexts in Sallis and Owen's (1999) review. However, class size and group cohesion were presented as weak physical activity correlates relating to supervised studies. Class size and group cohesion was not reported for community-based studies which may have included group-based physical activities. Absence of these correlates does not mean that these concepts did not occur; Sallis and Owen (1999) may just not have recorded them in their review or the community-based studies may not have reported them. Trost et al. (2002) noted that the majority of evidence is based on cross-sectional studies, which precludes the ability to infer causality. The authors therefore recommended further longitudinal and intervention research.

1.6.2 Effectiveness of Interventions to Increase Physical Activity Adherence

The benefits of physical activity rely on an individual's ability to engage in and maintain physical activity. Interventions have been developed to promote physical activity to both healthy members of the general population and to clinical samples. These interventions may be delivered through community, workplace, or healthcare settings, delivered face-to-face or through media, and delivered to an individual, family, or group (Dishman & Buckworth, 1996).

Hillsdon, Foster, Cavill, Crombie, and Naidoo (2005) summarised the evidence from 16 systematic reviews and concluded that interventions delivered within community settings are effective in producing short term changes in physical activity and are likely to be effective in producing mid to long term changes. Authors report that interventions that promote longer-term change incorporate regular contact with an exercise specialist and include activities not reliant on an exercise facility. However, only four of Hillsdon et al.'s (2005) reviews (Hillsdon & Thorogood, 1996; King, Rejeski, & Buchner, 1998; van der Bij, Laurant, & Wensing, 2002; Conn, 2003) examined group and solo physical activity contexts, and these presented ambiguous findings.

Hillsdon and Thorogood (1996) found that home-based interventions were more successful in increasing physical activity than facility-based interventions. However, the facility-based and home-based contexts did not represent activity performed alone and in a group; they represented activity performed at a facility and proximate to home. For example, one of the studies categorised as home-based recommended participation in a walking group (Lombard, Lombard & Winett, 1995). Likewise, one of the studies categorised as facility-based recommended participants jog alone (King & Frederiksen, 1984) while another did not allocate individuals to a programme and only provided written exercise advice (Reid & Morgan, 1979). In addition, facility and home-based studies included a range of types and intensities, making comparison between contexts difficult. For example, six out of the seven home-based studies included walking and jogging, whereas from the five facility-based studies, only one study included walking, one included walking and jogging, and one included jogging and swimming games. The remaining two facility-based studies included endurance exercise and participation in an exercise class. The walking studies in both conditions were successful in promoting physical activity, except for the facility based study that included swimming in addition to jogging. This suggests that low intensity, walking interventions are successful at increasing physical activity levels, which supports Hillsdon et al.'s (2005) original conclusion that activity not dependent on a facility is more effective in promoting physical activity, but does not provide evidence as to whether group or solo walking is more effective in increasing physical activity.

King, Rejeski and Buchner (1998) found that, for older adults with non-cardiovascular chronic illness, programmes using a supervised home-based format, or a combination (of group and home-based physical activity) reported comparable or better physical activity adherence to programmes that used a group format only. This lends support that solo physical activity may be more effective than group, but may just reflect the barriers of older adults, such as reduced mobility and the need for self-paced physical activity.

Van der Bij, Laurant, and Wensing's (2002) review featured healthy and inactive older adults, and compared the effectiveness of home-based, group-based, and educational interventions designed to increase physical activity. The authors found an inverse relationship between participation rate and length of intervention, but this was less strong in group-based interventions compared to home-based interventions. Short term interventions (with a duration of less than one year) demonstrated greater participation rates for group-based interventions (mean 90%) than home (84%), but were considered broadly comparable. Long term rates appeared to be more successful for home based (68%) compared to group based (49%). However, the authors note that insufficient data were available regarding the long-term effectiveness of group-based interventions. Improvements in group and solo physical activity interventions appeared to be unrelated to the type or frequency of physical activity, but the beneficial effect of behavioural reinforcement strategies was not clear (Van der Bij, Laurant & Wensing, 2002).

Conn (2003) found some support for both supervised facility-based and unsupervised physical activity interventions in increasing activity levels in older adults. Three of the 5 facility-based and 7 of the 12 home-based physical activity interventions led to an increase in physical activity. Conn (2003) reports that the three facility-based studies which found significant improvement in physical activity levels included additional motivational components, which may have accounted for their success. However, six of the home-based studies, and two facility studies which did not find the intervention successful also received motivational components. Motivational components may be an important confound (as with Van der Bij, Laurant & Wensing, 2002), but conclusions are limited in this review due to the poor methodological standards of the included studies.

Dishman and Buckworth's (1996) meta-analysis was not included in Hillsdon et al.'s (2005) review, but it suggests that interventions delivered in group settings were more effective than delivery to individuals and families. However, unsupervised interventions were more effective than supervised. Supervised interventions were defined as meeting with a member of the research team on a regular basis alone or in a group to receive the intervention. Unsupervised interventions were defined as meeting alone or in a group with instruction to continue with physical activity alone. The meta-analysis review spanned 127 studies and examined the effectiveness of interventions for increasing physical activity in community, worksite, school, home, and health care settings, including a variety of samples representing healthy individuals and patients with CHD, chronic illness, or physically or developmentally disabling conditions. The effectiveness of interventions was not related to sex, age group, or racial group. Behaviour modification was more effective than cognitive-behaviour modification, health education/risk appraisal, exercise prescription, school P.E. curriculum or a combination. Programmes were more effective when they included healthy individuals, but there were few studies including interventions with patients. More effective interventions included mediated delivery (compared to face to face, or a combination of deliveries) and were delivered in community settings (than those delivered in home, school, worksite, health care sites). Effectiveness was not related to the number of weeks per intervention, weekly frequency, daily duration or follow-up period. However, unsupervised active leisure time (where participants were free to engage in their choice of physical activity) was more effective than programmes prescribing strength, and aerobic or aerobic with other fitness activities and low intensity activities were more successful than higher intensity physical activity. However, this does not provide any conclusions as to the superiority of group versus solo physical activity contexts in promoting increased physical activity levels, as participants may have engaged in group or solo physical activity as part of their active leisure time. Dishman and Buckworth (1996) found that interventions reported a greater effect size when objective measures of physical activity were used. There is potential for bias and inflation of reported physical activity levels when they cannot be verified by a researcher. However, this study suggests that low intensity physical activities may be more rewarding as they are easier to achieve and maintain for unfit individuals. Personal choice of activity is important to engagement and maintenance of physical activity: Parfitt and Gledhill (2004) found adults who were given opportunities to engage with their chosen activities were more motivated, and reported less exertion and greater positive affect than those whose preferred choice was not met.

Overall, these reviews suggest that physical activity interventions are most effective when delivered in groups, but recommend activity that can be conducted close to the home which is not dependent upon using an exercise facility. Group physical activity may be more successful in promoting short term increases in activity level, but solo activities may relate to longer term maintenance. However, a major limitation present in all the mentioned reviews is very few included studies featuring a group and solo physical activity condition. Typically they included a non-exercising control group for comparison with either a group or home-based intervention. Therefore, these reviews provide inadequate evidence of the superiority of either group or solo contexts in promoting physical activity.

Only one meta-analysis (Burke et al, 2006) has overcome this limitation; it specifically included studies with a direct comparison between home-based physical activity (contact and no contact), collective groups (such as exercise classes) and true groups (defined as employing team building exercises to encourage cohesion). Burke et al. (2006) found no significant difference between these contexts in promoting physical activity adherence and suggested this may be related to the similar amount of contact participants in home-based and collective contexts received. Burke et al. (2006) suggested it may also be due to the definition of adherence; group attendance is more likely to be objectively measured where solo physical activity is more likely to be subjectively reported, which may result in bias.

In addition, non-completion rates may also bias reported attendance when comparing group and solo physical activity conditions. Blumenthal et al. (2007) found drop-out rates were greater for group physical activity than for solo and suggest this is due to context and classification. Blumenthal et al. (2007) categorised their participants as non-completers when they discontinued exercise for the remaining duration of their study. Therefore it was easier for participants assigned to solo physical activity to remain in the study by maintaining minimal involvement in the exercise programme. Using ITT analysis, attendance rates were slightly greater for home-based (93.9%) than supervised (82.9%) conditions. However when drop outs were excluded from analysis, completion rates were similar between home (68%) and supervised exercisers (67%) who completed at least 75% of the 48 scheduled sessions.

Preferences for group and solo physical activity may impact attrition rates differently. For example, random assignment to a group or solo physical activity condition may lead to attrition if an individual does not favour their assigned physical activity condition (highlighting the potential importance of choice found in Dishman & Buckworth's, 1996, review). Three of the reviews mentioned earlier (King, Rejeski, & Buchner, 1998; Conn, 2003; van der Bij, Laurant, & Wensing, 2002) focused on older adults, with King, Rejeski, and Buchner (1998) in particular finding home-based physical activity superior to group. However, older adults have reported a greater preference for solo physical activity over group (Mills, Stewart, Sepsis & King, 1997; Burton, Khan & Brown, 2012), which may have contributed to the effectiveness of solo physical activity over group. In contrast, younger adults were found to prefer group physical activity over solo (Burke, Carron & Eys, 2006). Further research is required to identify the effectiveness of group or solo physical activity contexts to promote physical activity engagement and adherence in younger adults.

1.6.3 Aims

The overall aim of this thesis was to evaluate the relationship between psychological distress and group and solo physical activity, and investigate factors involved in participation. The thesis will focus on healthy university students and members of the general population.

The first aim of this thesis was to examine the effectiveness of group and solo physical activity in improving psychological distress, specifically examining stress, depression and anxiety. As mentioned at the start of this chapter the first overarching research question was does group physical activity reduce psychological distress more than solo physical activity? Building on Burke et al.'s (2006) meta-analysis, the systematic review (Chapter 2) will compare the effectiveness of group versus solo physical activity contexts in reducing psychological distress. Chapter 3 uses a cross-sectional study to investigate the relationship between group and solo physical activity and psychological distress in university students and the general population. Chapter 4 will compare the improvement in stress, depression and anxiety of inactive university students assigned to group and solo physical activity conditions over a ten-week period.

Having established some support for the benefits of group physical activity, the second aim of this thesis was to investigate the different factors involved in group and solo physical activity, especially for inactive indivudals, with the intention of developing further intervention or strategies to facilitate group physical activity. The second overarching research question was what factors are important in promoting group compared with solo?

Chapter 3 examines the preferences, benefits, and barriers to engaging in group and solo physical activity, for both students and members of the general population (Chapter 3), using a scale developed for this purpose. The final study (Chapter 5) will investigate the engagement in group and solo physical activity of university students by utilising a social cognition model.

Chapter 2

Group versus Solo Physical Activity in the Reduction of Psychological Distress (Systematic Review)

2.1 Introduction

There have been a great number of studies investigating the relationship between physical activity and psychological distress; with several reviews and meta-analyses collating the findings. Six reviews support the anxiolytic effect of physical activity (Dunn, Trivedi, & O'Neal, 2001; Long & van Stavel, 1995; Martinsen, 2008; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991; Strohle, 2009; Wipfli, Rethorst, Landers, 2008). Likewise reviews have indicated that physical activity has an anti-depressant effect (Penedo & Dahn, 2005; Daley, 2008; Lawlor & Hopker, 2001; Arent, Landers & Etnier, 2000; Deslandes, Moraes, Ferreira, et al, 2009; Dunn, Trivedi, & O'Neal, 2001; Craft & Landers, 1998; Stathopoulou, Powers, Berry, Smits, & Otto, 2006; Pinquart, Duberstein & Lyness, 2007), stress reduction (Crews& Landers, 1987; Scully, Kremer, Meade, Graham & Dudgeon, 1998; Taylor, 2001) and improvement of quality of life (Netz, Wu, Becker & Tenenbaum, 2005 ; Spronk, Bosch, Veen, den Hoed & Hunink, 2005).

Lawlor & Hopker (2001) critiqued previous meta-analyses stating they lacked homogeneity and included studies which contained randomised and nonrandomised trials and studies with and without control conditions. In addition, studies were included which compared exercise to no treatment alongside studies which compared exercise and other forms of treatment. Studies have combined samples with diagnosed mental health and self-report measures and those which contain participants with both mental and physical health problems. They have included diverse measures of negative mood outcomes without addressing specific symptoms (Conn 2010a; 2010b). Lawlor & Hopker (2001) recommended that further research must be higher quality, examine samples from clinical populations, include adequate follow up and investigate social contact.

More recent reviews (Lawlor & Hopker, 2001; Conn, 2010a; 2010b) confirm that physical activity reduces depression and anxiety. Lawlor and Hopker (2001) found a large effect size of d=-1.1 when physical activity interventions were compared with no treatment (or d=0.66 accounting for methodological weaknesses, Ekkekakis, 2013), and a small effect size d=-0.3 when compared with cognitive therapy. Conn (2010a; 2010b) found supervised and unsupervised physical activity interventions were effective in reducing depressive symptoms (including a small effect size of d=0.37 among supervised physical activity studies, and a moderate effect size of d=0.52 among unsupervised studies) and anxiety symptoms (including a small effect size of d=0.22 when physical activity interventions were compared with no treatment) in adults without clinically diagnosed depression or anxiety. However, the anxiolytic effect was greater with supervised physical activity and the anti depressant effect with unsupervised (which was more effective when conducted at an exercise facility).

Conn (2010b) found low-intensity interventions were more effective than moderate or high intensity interventions in the reduction of depression. However low-intensity interventions were not sufficient to reduce anxiety, which required moderate or high intensity interventions (Conn, 2010a). In both of these meta-analyses, more effective interventions focused explicitly on physical activity behaviour rather than simultaneous multiple health behaviours. No difference was found between endurance and resistance exercise in the reduction of depression (Lawlor & Hopker, 2001), likewise aerobic fitness may not be the mechanism which reduces depression (Conn, 2010). This is supported by earlier research from Ossip-Klein, Doyne, Bowman, Osborn, McDougal-Wilson and Neimeyer (1989), who found no difference in depression scores between individuals completing aerobic (running) and nonaerobic (weight training) exercise. Simons, Epstein, McGowan and Kupfer (1985) concluded that it is unlikely that aerobic fitness was the mechanism responsible for improvement in psychological functioning.

The mechanisms of physical activity in reducing psychological distress remain largely unknown (Wipfli, Rethorst & Landers, 2008), however a number of theories have been proposed. These have been outlined previously (Chapter 1, Section 1.4), including physiological mechanisms relating to brain maintenance and plasticity involving neurogenesis, enhanced central nervous system metabolism and angiogenesis (Cotman, Berchtold & Christie, 2007), regulation of the hypothalamic-pituitary-adrenocortical (HPA) axis (which has been implicated in mood disorders, Watson & Mackin, 2006) and activation of the endocannabinoid system (Sparling, Giuffrida, Piomelli, 2003).

Psychological mechanisms may include an increased sense of self-esteem (Fox, 1999; Taylor & Fox, 2005), mastery or self-efficacy (Bandura, 1986). Social reinforcement may facilitate increased adherence and the therapeutic effect from fellow exercisers or through social support from family and friends (Blumenthal et al., 2007; Spirduso, Francis, MacRae, 2005, p. 253). Spirduso et al. (2005, p. 253) note that optimal degree of social interaction is subjective to the individual: coercing individuals who do not desire much social interaction may not be as beneficial to health. Strohle (2009) concludes that the mood enhancing effect of physical activity is likely a complex interaction of psychological and neurobiological mechanisms. While solitary physical activity has been found to reduce psychological distress (Van der Bij, Laurant, & Wensing, 2002), the psychological and physiological mechanisms may be enhanced by social interaction.

Conn's (2010a; 2010b) meta-analyses cannot conclude if group or solo-based physical activity is more effective than the other in reducing depression or anxiety. Conn (2010a;2010b) compared supervised and unsupervised contexts, which were defined as activity that was verified and activity that could not be verified. Although there may be some overlap with identified studies, these terms do not equate with group and solo physical activity contexts. In addition Conn's (2010a; 2010b) inclusion criteria did not require a study to contain both a supervised and unsupervised intervention, often studies compared a physical activity intervention with a no exercise control group.

However, one meta-analysis by Burke, Carron, Eys, Ntoumanis, and Estabrooks (2006) has directly compared group and home-based physical activity interventions, including home-based programmes with and without contact, collective condition (such as standard exercise classes), and/or true groups (defined as employing team building exercises to encourage cohesion). This was examined in relation to adherence, social interaction, quality of life, physiological effectiveness and functional effectiveness, and overall found there was a significant difference between true groups and exercise classes and also between exercise classes and home without contact. In support of the effect of social interaction in improving intervention effectiveness, true group exercise was considered superior to exercise classes, which in turn were superior to home-based exercise, although there were no statistically significant differences in the comparisons. However, in relation to quality of life (including components such as depression, stress, anxiety, and quality of life), no significant difference was found between home-based physical activity with contact and the collective condition, but the collective condition was superior, but not significantly to the home-based (without contact) condition. There were several limitations with Burke et al.'s (2006) analysis. The authors did not specify any psychological distress components within the search criteria, meaning additional studies relating to psychological distress may not have been identified with their terms. In addition, Burke combined a range of measures including depression, anxiety, stress, and quality of life to compare the effectiveness of group and home based physical activity. Constructs such as depression, anxiety and stress were not examined individually. These can be considered distinct constructs from each other (Lovibond, 1998; Henry & Crawford, 2005; Beck, Epstein, Brown, & Steer, 1988; Costello & Comrey, 1967; Lovibond & Lovibond, 1996) and may relate to group and solo physical activity differently.

The purpose of this systematic review was to determine whether group or physical activity is more effective in reducing psychological distress, examining separate concepts of psychological distress such as anxiety, stress and depression. It provides an update to Burke et al.'s (2006) findings by including more recent research.

2.1.1 Research Question

In physical activity related interventions, are group physical activity conditions significantly better at reducing psychological distress than solo physical activity conditions?

2.2 **Method**

2.2.1 Eligibility criteria

a) Population

Included studies were based on adult participants, aged 18+ years with no upper limit. Samples included both healthy adults and those with acute or chronic physical or mental illness. Studies which included children and adolescents (0-17 years old) were excluded. Studies were excluded if participants were not drawn from the same population sample per each physical activity condition.

b) Intervention

Studies were eligible for inclusion if they provided a physical activity based intervention of moderate or vigorous intensity.

Physical activity was defined as any bodily movement produced by skeletal muscles that require expenditure (Caspersen, Powell & Christenson, 1985). Cavill, Kahlmeier and Racioppi (2006) state that this definition comprises all types of activities, including walking, cycling, dance, traditional games, sports and intentional exercise. To ensure homogeneity between the studies and allow for adequate comparisons, studies featuring light intensity physical activity intervention were excluded.

Intensity was defined using metabolic equivalent estimates (METs), which represent the energy cost of physical activities as multiples of resting metabolic rate (Bryne, Hills, Hunter, Weinsier & Schutz, 2005), which is the minimum number of calories the body needs to support its basic physiological functions. Ainsworth, Haskell, Whitt, Irwin, Swartz, Strath, O'Brien, Bassett, Schmitz, Emplaincourt, Jacobs and Leon (2000) developed an extensive compendium of physical activities in terms of MET scores which has been used as a reference to define sedentary behaviour (1.0-1.5 METs), light intensity (1.6-2.9 MET), moderate intensity (3.0-5.9 METs) and vigorous intensity (6.0+ METs). The compendium was developed to facilitate the comparison of physical activity across studies, and therefore provides an estimation of physical activity intensity which may differ depending on individual differences (Ainsworth et al., 2000).

Studies were excluded from the review if they included a MET score physical activity intensity of 2.9 or less. This was to ensure the groups focused on exercise rather than low intensity physiotherapy (such as pelvic floor exercises for incontinence) or mindfulness based interventions which involve systematic tensing and relaxation of muscles.

Specific walking activity intensity was often not provided by authors; therefore it was estimated as having an intensity of 3.5 METS (the average intensity of walking, Ainsworth et al., 2000), physiotherapeutic exercises or back exercises were categorised as an intensity of 3.5 METs, unspecified home-based solo physical activities were estimated at 3.8 METs (Ainsworth et al., 2000). All studies contained at least one activity which was categorised as moderate intensity (of 3.0 METs or more).

c) Comparators

Studies were eligible for inclusion if they contained a group-based and a solo-based physical activity condition (but studies could include additional conditions to these such as a non exercise control group). Studies were eligible for inclusion if all participants per each condition were prescribed identical physical activity prescriptions.

Group physical activity was defined as any activity performed by at least two participants who were known to each other (not including a supervisor or physical activity leader). Studies which included a single participant supervised by physical activity leader or therapist were excluded. Solo physical activity was defined as any physical activity performed by participants in solitary conditions, without direct supervision (for example, following a DVD exercise programme at home, alone).

Studies were eligible for inclusion only if the total minutes of physical activity for group and solo conditions were within 20% of each other. This was defined to ensure homogeneity and adequate comparison between studies. Total minutes of physical activity were calculated by multiplying the number of sessions of physical activity by the mean length of each session in minutes by the length of intervention in weeks. Studies were eligible for inclusion if each condition prescribed different physical activity (for example land based activity versus water based activity).

d) Outcomes

Studies were eligible for inclusion if they included a measure of psychological distress, mental health aspect of quality of life or well-being which was compared between group and solo physical activity conditions.

Psychological distress referred to negative affect, including specific measures of depression, anxiety and stress. Depression was defined as feelings of sadness, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, feelings of tiredness, and poor concentration (World Health Organisation, WHO, 2014). Anxiety was defined as an emotional response to either objective or subjective stressors that results in a combination of feelings, cognitions and physiological changes that results in a feeling of apprehension, tension, and increased activity of the autonomic nervous system (Spielberger, 1972). Stress was defined as a perceived inadequacy to cope with demands of life or threats to an individual’s well being (Lazarus, 1966). Long and van Stavel (1995) explained stress as a process where stressors are appraised as exceeding one’s coping ability, differentiated from anxiety which was defined as an emotional response to stressors perceived as threatening or harmful to well-being (Lazarus & Folkman, 1984).

Quality of life consists of physical fitness, social integration, psychological stability, fulfilment of daily roles, and to experience social support in a materially and be economically safe environment independent of age, gender and culture (Bullinger, 2002). The review includes mental health related components from quality of life measures that assess social integration and psychological stability such as the 36-Item Short Form Survey from the RAND Medical Outcomes Study (McHorney, Ware, & Raczek, 1993). Measures were suitable for inclusion if acceptable psychometrics were published and available. Further reference to psychological distress refers to all measures included in this review.

e) Study Design

Studies were eligible for inclusion if they included pre and post intervention measures of psychological distress and compared this between conditions. If a study included a cross-over design, it was eligible for inclusion only if it reported psychological distress measures at the point before conditions switched. This point was considered the end point of the intervention. Both randomised controlled trials (RCTs) and non-randomised studies were included.

2.3 Information Sources

Studies were identified by searching electronic databases and scanning reference lists of articles. Searches were limited to studies published in English because of lack of feasibility for translation of texts and no lower limit was applied to the year of search. This search was applied to AMED (1885-present), CINAHL (1937-present), EMBASE (1980-present), PsycINFO (1806-present), SportDISCUS (1949-present), Web of Knowledge (1900-present). The literature search was conducted on 21/10/11.

2.4 Search

The following search string was used within each database: (‘exercise’ OR ‘physical activity’) AND (‘group’ OR ‘supervised’) AND (‘home’ OR ‘individual’ OR ‘solitary’ OR ‘solo’ OR ‘unsupervised’) AND (‘depress*’ OR ‘dysthym*’ OR ‘sad’ OR ‘sadness’ OR ‘bipolar’ OR ‘bi-polar’ OR ‘mania' OR ‘manic’ OR ‘cyclothymi*’ OR ‘unipolar’ OR ‘uni-polar’ OR ‘hopeless’ OR ‘hopelessness’ OR ‘anxiou*’ OR ‘anxiety’ OR ‘angst’ OR ‘worry’ OR ‘worried’ OR ‘stress*’ OR ‘mood’ OR ‘mood disorder’ OR ‘affect*’ OR ‘distress*’ OR ‘emotion*’ OR ‘psychological status’ OR ‘mental health’ OR ‘well being’ OR ‘wellbeing’ OR ‘well-being’). See A1 for a table summarising the number of responses to these search terms.

2.5 **Data Collection Process and Data Items**

Data was extracted by one researcher into a spreadsheet. Information was extracted from each study on: (1) characteristics of participants (including age, sex, health status); (2) type of intervention (including context, type, frequency, duration, intervention length); (3) outcome measure (including psychological distress difference between conditions) and is presented in Table 2.1.

2.6 **Risk of Bias in Individual Studies**

To grade the strength of the body of evidence 14 items were identified as of specific importance to study methodology and physical activity interventions. Two of these items were not accepted as part of the final quality criteria. The first item related to similar prescriptions of physical activity to each condition but was incorporated into the inclusion/exclusion criteria as differences in prescription were considered an important confound. The second item related to the assessment of similar physical activity levels at baseline per conditions but was excluded as the primary outcome of the review was psychological distress. This resulted in a quality criteria of ten (A2).

To ensure the validity of eligible studies, a pair of reviewers working independently, determined the adequacy of randomisation, validity of the psychological distress measure, blinding of participants, provision of similar programme, similar programme adherence, similar baseline psychological distress, appropriate sample size, similar attrition between conditions, appropriate period of follow-up, appropriate intention-to-treat (ITT) analysis and similar contact (A2).

2.7 **Summary Measures**

The primary measure was the difference in psychological distress between group and solo physical activity conditions post intervention (or at the point when conditions crossed-over).

2.8 **Planned Methods of Analysis**

Details of significant differences between conditions were extracted from studies. If not explicitly stated but means and standard deviations (SDs) were available, appropriate statistics were calculated to determine if differences between conditions post intervention were significant.

2.9 **Results**

2.9.1 Study Selection

The titles and abstracts of the 15,817 potentially relevant studies were screened for initial assessment of their suitability according to inclusion and exclusion criteria (Appendix A3) by one researcher, resulting in 48 studies (Figure 2.1). Upon further review, a further 29 studies were excluded. Five studies were excluded due to ambiguous reporting of physical activity conditions which could not be resolved via attempts to contact authors (one had no viable contact address and the remaining four did not respond to queries). Two studies were excluded as they did not compare psychological distress between adequate group and solo activity conditions. Two studies didn't record psychological distress immediately post intervention. Two studies included no measure of psychological distress. Three studies provided didn't physical activity prescriptions per participants per condition. One study did not include a form of moderate or vigorous intensity physical activity. One study did not include the same population in both group and solo physical activity conditions. Thirteen studies were excluded as the prescribed volume of group and solo physical activity were not within 20% of each other. As only one study provided a measure of stress, this measure was removed from analysis as there were no other studies to compare it with (King, 2002). The final review was based on the remaining 19 studies (Figure 2.1).

2.9.2 Study Characteristics

A summary of the study characteristics are included below (Table 2.1). The full details of the psychological distress measures can be found in Table 2.2.

a) Participants

Sixteen studies included a total of 1,361 participants allocated to group and solo physical activity conditions (excluding King et al., 1993, who did not provide sufficient information to determine this), 1408 completed baseline measurements, 968 completed the interventions (excluding King et al., 1993) and 1268 were included in analyses comparing group and solo physical activity conditions. Three studies did not provide sufficient information to determine the number of participants in group and solo physical activity conditions who were allocated to conditions, completed baseline measures, completed intervention and were included in analysis (Atousa, 2009; Cecchi et al., 2009; Yilmaz et al., 2003). The difference between the number of participants who completed the intervention and the number included in analysis is due to seven studies using ITT analysis.

Fourteen studies focused on samples of chronically ill participants including adults (Analay et al., 2003; Bravo et al., 1996; Cakit et al., 2010;; Evcik et al., 2008; Giallauria et al., 2006; Hsieh et al., 2009; Neuberger et al., 2007; Reeder et al., 2008; Regensteiner et al., 1997; Solak et al., 2008;Yilmaz et al., 2003) and older adults (over the age of 65; Cecchi et al., 2009; Timonen et al., 2002; Wu et al., 2010). Two studies sampled for depression using high scores on the BDI (Atousa, 2009) or through clinical diagnosis (Blumenthal et al., 2007). Two studies sampled healthy adults (King, Taylor, & Haskell, 1993; McGale, McArdle & Gaffney, 2011) and one study included healthy older adults (King et al., 2002).

The average number of males per study was 21.06, SD=23.93 (proportionally 32.05%, SD=34.75) and females 51.35, SD=40.96 (67.95%, SD=34.75, based on 18 studies excluding Regensteiner et al., 1997, who did not provide this information). The average age of participants was 56.35 years (SD=14.76) based on 18 studies as Atousa, 2009 did not provide sufficient information).

Table 2.1 Characteristics of All Included Studies

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
Analay, Ozcan, Karan, Diracoglu, and Aydin (2003)/ Turkey	Patients with ankylosing spondylitis	Depression (BDI)	Group (Intensive Exercise Program)	27	87/13	37.6 (11.3)	Stretching, mobilization, strengthening, postural, aerobic (static bicycle 15 – 30mins increasing), respiratory exercises	4-5	3	50-65	6	1035	Not reported
			Solo (Control Group, i.e. home exercises)	24	82/18	34.3 (7.9)	Stretching, mobilization, strengthening, postural, aerobic (static bicycle 15 – 30mins increasing), respiratory exercises		3	50-65		1035	Not reported
Atousa (2009) / Iran	Female university students enrolled in P.E. courses with high BDI scores	Depression (BDI)	Group (Group Training)	20	0/100	NR	Training (no further details provided)	NR	2	90	10	1800	Not reported
			Solo (Individual Training)	20	0/100	NR	Training (no further details provided)		2	90		1800	Not reported
			Control (Control Condition, no exercise)	20	0/100	NR	No exercise						

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
Blumenthal, Babyak, Doraiswamy, Watkins, Hoffman, Barbour, Herman, Craighead, Brosse, Waugh, Hunderliter, and Sherwood (2007) / USA	Patients with major depressive disorder	Depression (HAM-D)	Group (Supervised Exercise)	51	25/75	52 (7.0)	Aerobics (inc 10 minutes warm-up, 5 minutes cool-down)	NR	3	45	16	2160	Mdn sessions attended = 37; interquartile range = 15–41 sessions
			Solo (Home-Based Exercise)	53	26/74	53 (8.0)	Aerobics (10 min warm-up, 5 min cool down)		3	45		2160	Mdn sessions attended = 40; interquartile range = 29–48 sessions
			Medication	49	25/75	52 (8.0)	No exercise						
			Medication Placebo	49	23/77	52 (8.0)	No exercise						
Bravo, Gauthier, Roy, Payette, Dubois, Harvey, and Gaulin (1996) / Canada	Osteopenic (low bone mass) women	General Well-Being Schedule, Dupuy, 1978)	Group (Experimental Condition)	61	0/100	59.56 (5.2)	Warm-up (10mins), Walking/Aerobic alternating weekly (25mins), Stepping/Localised exercise (10/15mins), Cool-Down (5mins)	13-22	3	60	48	8640	Average attendance = 73%, average time per week = 120mins
			Solo (Home Condition)	36	0/100	60.33 (6.5)	Warm-up (10mins), Aerobic (25mins), Stepping/Localised Exercise (20mins), Cool-Down (5mins)		3	60		8640	Average attendance = 69%, average time per week = 59.5mins

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
Cakit, Nacir, Genç, Saraçoğlu, Karagöz, Erdem, and Ergün (2010) / Turkey	Patients with Multiple Sclerosis	Depression (BDI) Mental Health (SF-36)	Group (Condition 1)	14	36/64	36.4 (10.5)	Progressive resistance training (static bicycle ergometer, time variable due to sets, 5mins warm-up (walking) and stretches; 20-25mins of balance exercises; 5mins whole-body stretching.	NR	2	35+	8	560	Average adherence 93% (209/224 sessions)
			Solo (Condition 2)	10	20/80	43.0 (10.2)	5mins warm-up (walking) and stretches; 20-25mins of balance exercises; 5mins whole-body stretching.		2	35+		560	Average adherence = 60% (136/224 sessions)
			Control (Condition 3)	9	33/67	35.5 (10.9)	No exercise						
Enock, Nofri, Paperini, Conti,	skeletal impairment & difficulti	Mental Health (SF-36)	Group (Exercise Condition)	25	32/68	73.2 (6.0)	Low-Impact exercise to improve strength/flexibility/balance/aerobic capacity/performance	12	2	60	12	1440	Mean sessions attended = 27.7, SD=2.1

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
			Solo (Walking)	25	40/60	72.1 (5.4)	Walking		2	60		1440	Mean sessions attended = 26.8, SD=6.7
Evcik, Yigit, Pusak, and Kavuncu (2008) / Turkey	Patients with Fybromalgia Syndrome	Depression (BDI)	Group (Condition 1, aquatic exercise)	31	0/100	43.8 (7.7)	Poolside exercise (inc warm-up, active range of motion range of motion (ROM) exercises and relaxation, 20mins). Aquatic exercise (inc warm-up, aerobic exercise, active ROM, stretching, relaxation, 35mins). Cool down (5mins).	7-8	3	60	5	900	Not Reported
			Solo (Condition 2, home exercise)	30	97/3	42.8 (7.6)	Home exercise (no time specified) including warm-up, ROM, relaxation, aerobics, stretching, cooling down		3	60		900	Not Reported

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
Giallauria, Lucci, Pilerci, De Lorenzo, Manakos, Psaroudaki, Dagostino, Vitelli, Maresca, Del Forno, and Vigorito (2006) / Italy	Patients after acute myocardial infarction	(BDI) Anxiety (STAI-Y1,	Group (Condition A, Control Condition)	15	100/0	54 (8)	Cycling (using a cycling machine)		3	30	8	720	Not Reported
			Solo With ECG (Condition B, Study Condition)	15	100/0	60 (6)	Cycling (using a cycling machine)	NR	3	30		720	Not Reported
			Solo Without ECG (Condition C, second control condition)	15	100.0	58 (6)	Cycling (using a cycling machine)						Not Reported
Hsieh, Chen, Chuang, Chai, Chen, and He (2009) / Taiwan	Chinese patients with rheumatiod arthritis	Anxiety, Depression (Arthritis Impact Measurement Scales, AIMS)	Group (Supervised aerobic exercise)	15	0/100	54.1 (8.3)	Stretching (10min) warm-up (10min) Pool exercise (30min) cool-down (10min)	7-8	3	60	8	1440	100% attendance
			Solo (Home exercise	15	0/100	51.2 (12.0)	Stretching (10min) warm-up (10min) aerobic exercise with walking/ bicycling/aerobic dance/swimming (30min) cool-down (10min) Participants were also allowed to accumulate physical activity in smaller chunks (e.g. 3x 10mins)		3	60		1440	Mean adherence = 52% (SD=13, range 32-75%)

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
King, Taylor, and Haskell (1993) / USA	Healthy adults aged between 50-65	Manifest Anxiety Scale) Depression (BDI)	Group (Higher Intensity Group)	74	Total sample= 55/45	Total sample= Mean age men 56.2 (4.0), women 57.0 (4.4)	Group Based Exercise Training Sessions (40mins endurance training was walking/running on a treadmill or use of stationary cycle)	NR	3	60	48	8640	Mean attendance = 52.6%.
			Solo Hi-Intensity (Higher Intensity Home)	77			Same as group, 40mins endurance training, walking/jogging		3	60		8640	Approx 75% attendance
			Solo Lo-Intensity (Lower Intensity Home)	74			30mins walking/jogging Access to stationary bicycle if injury/symptoms dictated		5	30			Approx 75% attendance
			Control	75			No exercise						
and Wolfson (2002) / USA	Older Adults	Mental Health (SF-36)	Group (Intervention)	80	22/78	77.0 (4.6)	Warm-up/Strength & Endurance 15mins/ Progressive Resistance 60mins	8-10	Week 1-24, 3 Week 25-48, 1	75	72	7200	Week 1-24, mean level of adherence = 61%
							Transitioned from group activity to solo Maintenance/ Strength/ Endurance /Balance/ Flexibility		Week 25-48, 2 Week49-72, 3	75			
			Solo (Home Control)	75	20/80	77.9 (4.4)	Booklet on increasing moderate exercise (Home exercise, walking, shopping, swimming, gardening, stretching) to 180mins a week. Formal exercise classes		Not specified	Increasing to 180 minutes per week		8640	Week 1-24, mean level of compliance = 66%

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
							or use of resistance equipment was not permitted.						
McGale, McArdle, and Gaffney (2011) / Ireland	Sedentary Young Men (no major physical health problems)	Depression (BDI)	Group (BTN, team sport CBT-guided intervention)	29	0/100	29.24 (4.8)	Warm-up (10mins), drills (5mins), conditioned football game (10mins), football game (25mins), warm-down (5mins)	5-12	2	55	10	1100	Mean attendance M=14.82 (SD=4.19)
			Solo (IE Individual Exercise)	27	0/100	27.67 (5.5)	Use of gym equipment with HR monitors; warm-up (10mins), exercise (40mins), warm-down (5mins).		2	55		1100	Mean attendance 15.65 (SD=3.89)
			Control	28	0/100	27.0 (4.4)							
Neuberger, Aaronson, Gajewski, Embretson, Cagle, Loudon, and Miller (2007) /USA	Patients with Rheumatoid Arthritis	Depression (CES-D) Depression (POMS)	Group (Class Exercise Condition)	68	Total sample = 17/83	Total sample= median age 55.5 (Range 40-70)	Warm-Up, Low-impact aerobics, strengthening, cool-down	NR	3	60	12	2160	Median sessions attended = 30 out of 36 sessions (range 4-36)
			Solo (Home Exercise Condition)	79			Warm-Up, Aerobic exercise, Strengthening, Cool-Down (using a video tape)		3	60		2160	Median sessions attended = 30 out of 36 (range 3-36)

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
			Control	73			No exercise (maintain baseline levels)						
Reeder, Chad, Harrison, Ashworth, Sheppard, Fisher, Bruner, Quinn, Pahwa, Hossain (2008) / Canada	Older adults with chronic health conditions	Mental Health (SF-36))	Group (Class-based)	84	26/74	60.3 (7.2)	Warm-up (10mins) moderately vigorous endurance exercise (walking bicycle or rowing, 30mins) light resistance training (20mins)	NR	3	60	12	2160	Endurance sessions - M attendance = 2.7 days per week, mean duration = 26.0 mins Resistance training - M frequency = 1.3 days per week, M duration = 8.2 mins

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
			Solo (Home-Based)	88	27/73	60.4 (7.7)	Stretching, moderately vigorous endurance exercise, light resistance training		3	60		2160	Endurance sessions - M attendance = 3.0 days per week, M duration = 29.7 mins Reported resistance training - M frequency = 0.7 days per week, M duration = 7.7 mins
Regensteiner, Meyer, Krupski, Cranford, and Hiatt (1997) / USA	Patients with peripheral arterial occulsive disease	Mental Health (SF-20)	Group (Hospital-based exercise rehabilitation program)	10	NR/NR	65 (7)	Treadmill (inc warm-up, cool-down)	NR	3	35 -50	12	1530	36 sessions completed within 13.5 (SD=1.4) weeks
			Solo (Home-based program)	10	NR/NR	64 (7)	Walk		3	35 -50		1530	36 sessions completed within 14.1 (SD=1.7) weeks
Ozbulut, Babaoglu, Toktas, Evcik, and	menopausal women with osteoporosi	(SF-36) Depression (BDI,	Group (Water Exercise, WE)	30	0/100	55.8 (4.6)	Water-based exercise including warm-up, stretches, strength, posture, gait, vestibular proprioception and balance activities.	8-10	5	35	3	525	All participants completed all the exercises.

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
			Solo (Land Exercise, LE)	30	0/100	56.0 (4.1)	Home based exercise (balance/ strength/stretching/relaxation)		5	40		600	
Timonen, Rantanen, Timonen, & Sulkava (2002) / Finland	Frail older women after discharge from hospital	Depression (Zung Self-Rating Depression Scale, Zung, 1965)	Group (Strength Training Intervention)	34	0/100	83.5 (4.1)	Training classes (warm-up, resistance training, functional training, relaxation)	3-8	2	90	10	1800	Mean sessions attended = 18 (range 11-20)
			Solo (Home Exercise Control)	34	0/100	82.6 (3.7)	"Two sets of 15 Repetitions" same functional exercises to group		2-3	NR (assumption similar to group)		1800	22 (69%) participants reported having done regular home exercise at least once a week for average of 68mins (SD=58.7) a week
Wu, Keyes, Callas, Ren, and Bookchin (2010) / USA	Elders at risk for falls	Mental Health (SF-36)	Group (Comm-Ex – Community Centre-based exercise)	20	17/83	74.1 (6.9)	Group Tai-Chi Chaun (inc warm-up, breathing, stretching)	NR	3	60	15	2700	Attendance rate = 71% (SD=27), total exercise time = 31hrs (SD=12)
			Solo, DVD (Home-Ex –Home video-based exercise)	22	12/88	75.9 (6.3)	Tai Chi Chaun (inc warm-up, breathing, stretching) on DVD		3	60		2700	Attendance rate =38% (SD=46), total exercise time = 17hrs (SD=21)

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
			Solo, Home Tele-Link (Tele-Ex – Live Interactive Telecommunication -based exercise)	22	12./88	76.1 (7.9)	Tai-Chi Chaun (inc warm-up, breathing, stretching) at home on a tele-link with instructor.		3	60			Attendance rate = 69%, (SD=27), total exercise time = 30hrs (SD=12)
Yílmaz, Yílmaz, Merdol, Parlar, Sahin and Kuran (2003) / Turkey	Patients with lumbar micridiscectomy	Depression (BDI)	Group (Condition 1 – Dynamic Lumbar Stabilization Exercises)	14	57/43	46.0 (9.8)	Dynamic lumbar stabilization exercises Notes: Before the exercise programme, the soft tissue flexibility and range of motion of these patients were increased through stretching exercises, with 5–	2-3	3	40	8	960	Not Reported

Study/ Country	Sample	Psychological Distress Category (Measure)	Conditions (As described in study)	N	Sex M/F (%)	Mean Age at Baseline (S.D.)	Physical Activity	N Per Group Condition	Frequency (per week)	Session Duration (mins)	Intervention Length (weeks)	Total Physical Activity (mins)	Attendance
							10 minute relaxation periods.						
			Solo (Condition 2 - Home exercise program)	14	44/57	41.0 (8.9)	Flexion and extension (Williams-McKenzie), pelvic tilt and exercises for strengthening abdominal and trunk muscles		3	40		960	Not Reported
			Control (Condition 3 – Control (no exercise)	14	57/43	42.79 (11.4)	No exercise						

NR – Not Reported

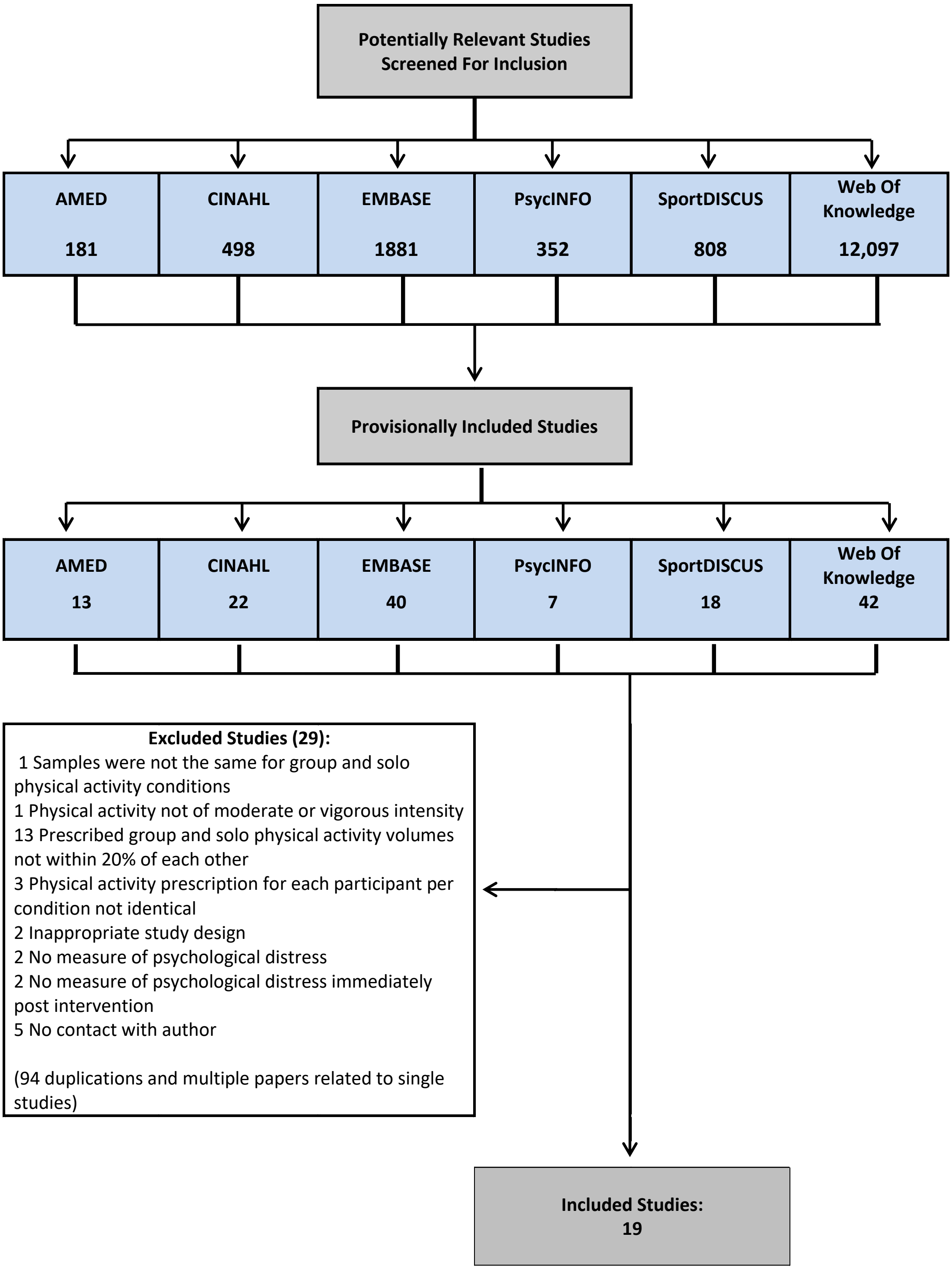

Figure 2.1 Flow Diagram of Study Identification and Acceptance Process

b) Interventions

Physical activity interventions

The mean length of intervention throughout the 19 studies was 17.42 weeks (SD=19.02), ranging from 3 to 72 weeks. Interventions included a variety of physical activities including aerobic, balance, flexibility, stretching, and resistance training. Frequencies of activity sessions ranged from two to five times per week, for periods ranging from 30 minutes to 90 minutes in both group and solo physical activity conditions. Ten studies reported the number of participants per physical activity group which ranged from 2 to 17.5 (M=8.35, SD=4.17, Mdn=8; Analay et al., 2003; Bravo et al., 1995; Cecchi et al., 2009; Evcik et al., 2008; Hsieh et al., 2009; King et al., 2002; McGale et al., 2011; Solak et al., 2008; Timonen et al., 2002;Yilmaz et al., 2003).

The mean frequency of prescribed group physical activity throughout the 19 studies was 2.79 times per week (SD=0.71). The mean session length of group physical activity was prescribed for 56.58 minutes per session (SD=16.52). In studies that included incremental session durations throughout the intervention, the mean minutes were calculated and included in this analysis (including Analay et al., 2003; King et al., 1993 Regensteiner et al., 1997). The mean frequency of solo physical activity was 3.11 times per week (SD=0.78). The mean duration of solo physical activity was 48.33 minutes per session (SD=14.14). This was based on 18 studies, as Kinget al. (2002) did not define the frequency and duration of solo physical activity per week, but recommended participants engage in 180 minutes per week. This is the equivalent to 3 sessions of 60 minutes of physical activity per week, if this were the case, the mean frequency of solo physical activity would be 2.84 times per week (SD=0.69) for 56.05 minutes per session (SD=15.62). Overall the median frequency and duration of both group and solo physical activity was 3 times per week, for a session duration of 60 minutes.

The total mean volume of minutes of prescribed physical activity (calculated by multiplying the minutes per session, by frequency of sessions per week and total weeks of intervention) throughout interventions was similar between group

(M=2498.42, SD=2602.50) and solo physical activity conditions (M=2578.16 SD=2760.01,A4The range (525 to 8640 minutes) and median minutes of group and solo physical activity were identical (Mdn = 1530 minutes).

Non-Physical Activity Interventions

Twelve studies provided physical activity with no additional reported interventions. The interventions found in the remaining seven studies (Bravo et al., 1996; Cakit et al., 2010; Giallauria et al., 2006; King et al., 2002; McGale, McArdle, & Gaffney, 2011; Reeder et al., 2008; Timonen et al., 2002) have been grouped into three categories; educational and informational; support and counselling; and the provision of unsupervised social interaction beyond the physical activity session.

Five studies provided education and informational seminars (Bravo et al., 1996; Giallauria et al., 2006; King 2002; McGale, McArdle, & Gaffney, 2011; Reeder et al., 2008). Bravo et al. (1996) provided bi-monthly seminars throughout the year long intervention to both group and solo physical activity conditions on risk factors, nutrition, medical treatments and fall prevention. Giallauria et al. (2006) provided a cardiac rehabilitation programme for those in the group physical activity condition. In addition to physical activity, the programme included functional and prognostic evaluation, risk factor assessment, counselling, educational and behavioural intervention, and pharmacologic control. King et al. (2002) provided 4 group meetings to those in both group and solo physical activity conditions to discuss healthy feet, home safety, nutrition, stress reduction, and exercise. In addition, all participants received a monthly newsletter with exercise and health tips, and other topical information. McGale, McArdle, and Gaffney (2011) provided a group-based integrated sport and cognitive-behavioural therapy (CBT) guided intervention. Each physical activity session featured different kinds of team football games that incorporated features of CBT including guided discovery, psychoeducation, and skill building. Each session included a different theme such as relaxation, teamwork, identifying personal positive strength, goal setting, problem solving, resilience, avoiding harmful situations, self-care behaviour and communication. For example, a game to facilitate teamwork and communication required each player to touch the ball before a goal could be scored, thus promoting communication and working together as a coherent team in achieving a group goal. Reeder et al. (2008) provided 10 lifestyle education classes to both participants in group and solo physical activity conditions that included topics such as the health benefits of physical activity, exercise prescription, risk factor awareness, goal setting, healthy nutrition, stress management, proper foot care and footwear, back care and managing arthritis.

Five studies provided support and counselling (Bravo et al., 1996; Cakit et al., 2010; Giallauria et al., 2006; King et al. 2002; Reeder et al., 2008). Bravo et al. (1996) provided 15 instructional group sessions throughout the year long intervention for participants allocated to the solo physical activity condition. These sessions were designed to encourage exercise participation in spite of difficulties and to promote healthy life habits. As previously mentioned, Giallauria provided counselling as part of the cardiac rehabilitation programme available to participants allocated to the group physical activity condition. Bravo et al. (1996), Cakit et al. (2010), King et al. (2002) and Reeder et al. (2008) regularly phoned participants allocated to the solo physical activity condition to remind participants to complete exercise logs, promote engagement, answer questions, discuss safety principles and provide individual feedback, support and encouragement.

Two studies provided unsupervised opportunities for socialisation. McGale, McArdle, and Gaffney (2011) provided a light snack after group physical activity sessions, and Timonen et al. (2002) provided transport and lunch for participants attending for group physical activity.

c) Comparator Conditions

Ten studies included contained two conditions comparing group and solo physical activity (Analay et al., 2003; Bravo et al., 1996; Cecchi et al., 2009; Evcik et al., 2008; Hsieh et al., 2009; King et al., 2002; Reeder et al., 2008; Regensteiner et al., 1997; Solak et al., 2008 Timonen et al., 2002). Five studies included a non-exercising control group (Atousa, 2009; Cakitet al., 2010; McGale, McArdle, & Gaffney, 2011; Neuberger et al., 2007; Yílmaz et al., 2003). One study included medication and medication placebo groups (Blumenthal et al., 2007). Two studies contained two variations of solitary physical activity; solo physical activity with and without ECG transmission (Giallauria et al., 2006) and high and low intensity solitary physical activity (King, Taylor, & Haskell, 1993). One study (Wuet al., 2010) included solo activity conditions where individuals exercised with a DVD and a solo activity condition where participants viewed an exercise instruction on a video link.

d) Outcomes

The 19 studies included 26 measures of psychological distress. These studies were categorised into those which specifically measured depression, anxiety and stress, and mental health. Thirteen studies measured depression, three measured anxiety, one measured stress, and eight studies measured mental health using a quality of life measure (Table 2.2). As there was no comparator for stress this measure was not included in the review.

Table 2.2 Psychological Distress Measures

Category	Measure	Study
Anxiety	AIMS (Meenan, Gertman, Mason, 1980, anxiety component)	Hsieh et al. (2009)
	State and Trait Anxiety (STAI-YI, STAI-Y2 Spielberger, Gorsuch & Lushene, 1970)	Giallauria et al. (2006)
	Taylor Manifest Anxiety Scale, Short Form (TMAS; Bendig, 1956)	King, Taylor & Haskell (1993)
Depression	Arthritis Impact Measurement Scales (AIMS, Meenan, Gertman, Mason, 1980, depression component)	Hsieh et al. (2009)
	Beck Depression Inventory (BDI, Beck, Ward, Mendelson, Mock, & Erbaugh, 1961)	Analay et al. (2003)
		Atousa, 2009)
		Cakit et al. (2010)
		Evcik et al. (2008)
		Giallauria et al. (2006)
		King, Taylor & Haskell, (1993)
		McGale, McArdle & Gaffney (2011)
		Solak et al. (2008)
		Yílmaz et al. (2003)
	Centre for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977)	Neuberger et al.(2007)
	Hamilton Depression Rating Scale (HAM-D, Hamilton, 1960)	Blumenthal et al.(2007)

Category	Measure	Study
	Profile of Mood States (POMS McNair, Lorr, & Droppleman, 1971, depression component)	Neuberger et al. (2007)
	Zung Self-Rated Measure of Depression (Zung, 1965)	Timonen et al. (2002)
Stress	Perceived Stress Scale (PSS, Cohen, Kamarck, & Mermelstein, 1983)	King, Taylor & Haskell (1993)
Mental Health	Life Orientation Test (Scheier & Carver, 1985)	Neuberger et al. (2007)
	Short-Form Health Survey,SF-36, Mental Health Component (McHorney, Ware, & Raczek, 1993)	Cakit et al. (2010)
		Cecchi et al. (2009)
		King et al.(2002)
		Solak et al. (2008)
		Wu et al.(2010)
	Short-Form Health Survey, SF-12 (Ware, Kosinski &, Keller, 1996)	Reeder et al. (2008)
	Short-Form Health Survey, SF-20 (Ware, Sherbourne & Davies, 1992	Regensteiner et al. (1997)

e) Study design

Eighteen of the 19 studies were RCTS, with the remaining study being an un-randomised controlled trial (Giallauria et al., 2006). One study included a cross-over design where participants allocated to the group physical activity condition switched over to solo physical activity after 12 months, while participants allocated to the solo physical activity condition exercised alone for 18 months (King et al., 2002). Outcomes from the 12 month measure for both group and solo conditions were included in analysis.

f) Attrition

The overall average attrition was 16.32% (SD=11.90, Mdn=15.97, excluding Atousa, 2009; Cecchi et al., 2009; Yilmaz et al., 2003, who did not provide sufficient information). The mean attrition was somewhat similar between group (M=15.78%, SD=13.41, Mdn=13.33%) and solo physical activity conditions (M=16.14%, SD=15.92, Mdn=10.23%, excluding Atousa, 2009; Cecchi et al., 2009; Yilmaz et al., 2003). Median averages indicated there was slightly less attrition from the solo physical activity condition than group.

g) Follow-Up

Eight of the 19 studies (Analay et al., 2003; Blumenthal et al., 2007; Cecchi et al., 2009; Evcik et al., 2008; King, Taylor, & Haskell, 1993; McGale, McArdle & Gaffney, 2011; Solak et al., 2008; Timonen et al., 2002) included a follow-up from the intervention period. The mean follow-up period was 34.25 weeks (SD=30.41), ranging from 6 to 96 weeks.

2.10 Summary of Study Characteristics

A summary of study characteristics is displayed in Table 2.3, representing data from group and solo physical activity contexts only. One study that measured anxiety reported a group size of 5 to 12 participants per group physical activity condition (Hsieh et al., 2009). Seven studies that measured depression reported a mean group size of 6.43 participants per group (SD=2.35, Mdn=7.5; Analay et al., 2003; Evcik et al., 2008; Hsieh et al., 2009; McGale et al., 2011; Solak et al., 2008; Timonen et al., 2002; Yilmaz et al., 2003). Four studies that measured mental health found a mean group size of 11.88 (SD=4.01, Mdn=10.5; Bravo et al., 1995; Cecchi et al., 2009; King et al., 2002; Solak et al., 2008)

Table 2.3 Characteristics of All Studies Included in Current Review (and subgroups comparing Depression, Anxiety, Stress, and Mental Health)

	All Reviewed Studies				Studies Comparing Depression				Studies Comparing Anxiety				Studies Comparing Mental Health			
	Studies	Mean	Median	SD	Studies	Mean	Median	SD	Studies	Mean	Median	SD	Studies	Mean	Median	SD
Age	18	56.35	56.25	14.76	12	50.37	52.58	13.89	3	55.53	56.60	2.52	8	63.19	62.43	12.29
Males (%)	17	32.05	25.00	34.75	12	37.04	27.09	39.99	3	51.43	54.30	50.06	7	18.50	21.29	14.06
Females (%)	17	67.95	75.00	34.75	12	62.96	72.92	39.99	3	48.57	45.70	50.06	7	81.50	78.71	14.06
Attrition from Group Physical Activity Condition (%)	15	15.78	13.33	13.41	10	15.95	14.07	13.98	2	6.67	6.67	9.43	6	12.87	9.05	13.83
Attrition from Solo Physical Activity Condition (%)	15	16.14	10.23	15.92	10	12.89	8.58	13.55	2	6.67	6.67	9.43	6	18.88	13.26	20.02
Frequency of Group Physical Activity (Per Week)	19	2.84	3.00	0.69	13	2.85	3.00	0.80	3	3.00	3.00	0.00	8	2.88	3.00	0.99
Frequency of Solo Physical Activity (Per Week)	18	2.83	3.00	0.71	13	2.85	3.00	0.80	3	3.00	3.00	0.00	7	3.00	3.00	1.00
Session Duration of Group Physical Activity (Mins)	19	57.37	60.00	16.36	13	55.19	57.50	18.94	3	50.00	60.00	17.32	8	53.44	60.00	14.33
Session Duration of Sol Physical Activit (Mins)	18	56.67	60.00	15.90	13	55.58	57.50	18.54	3	50.00	60.00	17.32	7	51.07	60.00	11.35
Total volume o Group Physical Activity (Mins)	19	2112.37	1440.00	2148.54	13	1830.77	1100.00	2122.94	3	3600.00	1440.00	4379.59	8	3094.38	1845.00	3090.25
Total volume o	19	2192.11	1440.00	2350.70	13	1836.54	1100.00	2119.20	3	3600.00	1440.00	4379.59	8	3283.75	1845.00	3382.28

Solo Physical Activity (Mins)																
N in group exercise	10	8.35	8.00	4.17	6	6.25	6.50	2.52	1	7.50	7.50		3	12.83	12.00	4.31
Additional Educational/ Informational Interventions	4				1				1				3			
Additional Support/ Counselling Interventions	3				1				1				3			
Additional Unsupervised Socialisation Intervention	2				2				0				0			

2.11 **Risk of Bias within Studies**

To examine the validity of the included studies, a pair of reviewers worked independently to assess the studies (Table 2.4 for a summary of study ratings). Scores of 3 represent well covered, 2 adequately addressed, 1 poorly addressed and 0 not addressed or not reported. An average score was calculated for studies that included two measures in which the assessment criteria applied. There was a very high level of inter-rater reliability ($K=0.84$, $p<0.01$; Landis & Kock 1977; Fleiss, Levin, Paik, & Fleiss, 2003). The majority of studies used appropriate randomisation procedures and acceptable psychological distress measures. Just over half of studies did not use adequate blinding for those assessing, scoring or analysing data. Two thirds of studies provide adequately similar interventions (in addition to physical activity) to participants in group and solo physical activity conditions. Four fifths of the studies adequately included a group and solo physical activities of the same intensity. One third of studies did not report adherence; of the remaining studies, three quarters reported adequate similarity of adherence between group and solo physical activity conditions. All studies reported there was no significant difference in baseline psychological distress scores between group and solo physical activity conditions, however three studies reported baseline psychological distress measures were one or more standard deviations from each other. Only five studies included an acceptable sample size, the majority of studies included studies with small samples. Four studies did not report attrition, eleven studies had adequately similar attrition rates from group and solo physical activity conditions. Of the four studies that had dissimilar attrition rates, only two used ITT analysis. A third of the studies in total utilised ITT analysis. The majority of studies did not include appropriate follow-up or similar frequency of contact between group and solo physical activity conditions.

2.12 **Results of Individual Studies**

There were 26 measures of psychological distress throughout the 19 studies. Table 2.5 presents differences in psychological distress between group and solo physical activity conditions determined through t-tests or repeated measures ANOVA. All studies reported no significant differences between baseline psychological distress measures in group and solo physical activity conditions, therefore t-tests comparing post intervention psychological distress measures between group and solo physical activity conditions were considered acceptable.

Four studies (King, Taylor & Haskell, 1993; Neuberger et al., 2007; Reeder et al., 2008; Regensteiner, et al., 1997) did not explicitly state significance values when comparing difference for group and solo activity conditions. Therefore, a paired samples t-test calculator (http://graphpad.com/quickcalcs/) was used to confirm outcomes and code studies appropriately. Group physical activity was significantly superior to solo in reducing depression and anxiety in men but not women in King, Taylor and Haskell (1993) study. However the significant difference did not persist when the sample included both men and women, thus the study was coded as finding non-significant differences for all measures, between conditions. Two measures within Neuberger et al. (2007) and Reeder et al.'s (2008) studies found group physical activity significantly superior to solo. The remaining measures were coded as finding no significant difference between conditions. Solak et al. (2008) reported the percentages of participants experiencing normal, mild to moderate and moderate to severe depression in each condition. Significance levels were only presented if reported in studies or calculated using summary data previously described.

Table 2.4 Risk of Bias in Individual Studies

Study	Randomisation	Psychological Distress Measure	Blinding	Similar Programme Available	Similar Prescribed Physical Activity Intensity	Treatment/Programme Adherence	Baseline Psychological Distress	Appropriate Sample Size	Similar Attrition	Appropriate Follow-Up	Appropriate ITT Analysis	Similar Frequency of Contact	Total
Atousa (2009)	1	3	0	3	0	0	3	1	0	0	0	0	11
Giallauria et al. (2006)	0	3	0	1	3	0	3	1	3	0	0	1	15
Yilmaz et al. (2003)	2	3	0	3	3	0	2	1	0	0	0	1	15
Cakit et al. (2010)	3	3	2	0	1	1	2	1	1	0	0	2	16
Evcik et al. (2008)	1	3	0	3	1	0	0	1	3	3	0	1	16
Solak et al. (2008)	1	3	0	3	2	3	1.5	1	0	1	0	1	16.5
Wu et al. (2010)	3	3	0	3	3	0	3	1	1	0	1	0	18
Bravo et al. (1995)	3	3	2	1.5	3	1	3	1	1	0	0	1	19.5
Hsieh et al. (2009)	3	3	1	3	1	1	3	1	3	0	0	1	20
Timonen et al. (2002)	3	3	0	0	2	2	3	1	1	2	2	1	20
Reeder et al. (2008)	3	3	1	3	2	1	0	3	3	0	1	2	22
King et al. (1993)	3	3	2	3	3	1	3	3	0	0	0	1	22
Regensteiner et al. (1997)	2	3	0	3	3	3	2	1	3	0	0	2	22
McGale et al. (2011)	3	3	2	0	2	3	3	1	2	1	2	1	23
Analayet al. (2003)	3	3	2	3	3	0	3	1	3	1	0	2	24
Neuberger et al. (2007)	3	3	2	3	2	3	3	3	2	0	1	0	25
Cecchi et al. (2009)	3	3	2	3	2	3	3	1	3	3	0	0	26
King et al. (2002)	3	3	2	1.5	2	3	3	3	2	0	3	1	26.5
Blumenthal et al. (2007)	3	3	2	3	3	3	3	2	2	3	3	2	32

Table 2.5 Psychological Distress Measures at Baseline and Post Intervention and Differences between Conditions Post Intervention

Authors	Measure	Group Physical Activity Condition						Solo Physical Activity Condition						Differences Between Conditions Post Intervention
		Baseline Measures			Post Intervention Measures			BaselineMeasures			Post Intervention Measures			
		N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	
Anxiety														
Giallauria et al. (2006)	STAI-Y1	15	39	5.0	15	36.0	6.0	15	37.0	5.33	15	33.8	7.52	No significant difference
Giallauria et al. (2006)	STAI-Y2	15	34	5.0	15	35.0	7.0	15	33.4	6.3	15	33.0	8.7	No significant difference
Hsieh et al. (2009)	AIMS	15	2.4	1.72	15	2.07	1.03	15	2.13	1.3	15	1.93	1.1	No significant difference
King, Taylor & Haskell (1993)	SF Taylor Manifest Anxiety Scale	74	5.35	4.4	74	3.60	3.65	77	5.55	3.95	77	4.3	3.8	No significant difference t(149)=1.15, p=0.25
Depression														
Analay et al. (2003)	BDI	27	5.52	4.56	23	3.95	3.21	24	6.31	4.72	22	5.9	6.62	Group physical activity significantly superior to solo
Atousa (2009)	BDI	20	15.5	3.1	20	6.45	2.45	20	15.5	3.05	20	8.45	3.18	Group physical activity significantly superior to solo
Blumenthal et al. (2007)	HAM-D	51	16.0	4.0	51	8.8	6.9	53	17.0	5.0	53	9.9	6.9	No significant difference, p=0.51 (ITT, p=0.62)
Cakit et al. (2010)	BDI	14	22.8	12.7	14	17.2	12.3	10	40.2	15.8	10	41.8	18.3	Group physical activity significantly superior to solo, p<0.01
Evcik et al. (2008)	BDI	31	-	-	31	-	-	30	-	-	30	-	-	No significant difference
Giallauria et al. (2006)	BDI	15	15.1	5.0	15	16.4	3.0	15	16.2	4.5	15	15.8	2.2	No significant difference

Authors	Measure	Group Physical Activity Condition: Baseline Measures N	Mean	SD	Group: Post Intervention Measures N	Mean	SD	Solo Physical Activity Condition: BaselineMeasures N	Mean	SD	Solo: Post Intervention Measures N	Mean	SD	Differences Between Conditions Post Intervention
Hsieh et al. (2009)	AIMS	15	1.73	1.03	15	1.73	1.1	15	1.67	1.05	15	1.6	1.12	No significant difference
King, Taylor & Haskell (1993)	BDI	74	5.35	5.0	74	5.25	3.95	77	5.5	4.6	77	5.55	3.45	No significant difference t(149)=0.33, p=0.74
McGale et al. (2011)	BDI	38	9.45	7.0	22	5.22	5.74	36	8.94	6.98	23	4.27	5.91	No significant difference
Neuberger et al. (2007)	CES-D	68	14.81	8.12	68	13.74	9.46	79	10.62	7.74	79	10.45	8.16	Group physical activity significantly superior to solo, t(145) = 2.26, p=0.03
Neuberger et al. (2007)	POMS (Depression component)	68	0.56	0.67	68	0.49	0.62	79	0.46	0.59	79	0.36	0.67	No significant difference, t(145)= 1.21, p=0.23
Solak et al. (2008)	BDI Level (%) Normal		36.7			76.7			13.2			10.0		Rate of those whose depression level became normal was greater for those in group physical activity condition than those in solo physical activity condition (p<0.01).
	BDI Level (%) Mild-Moderate		56.7			23.3			66.7			70.0		
	BDI Level (%) Moderate-Severe		6.6			0.0			20.0			20.0		
Timonen et al. (2002)	Zung	26	47.3	7.8	26	44.2	9.0	32	48.1	10.1	32	49.4	7.6	Group physical activity significantly

Authors	Measure	Group Physical Activity Condition						Solo Physical Activity Condition						Differences Between Conditions Post Intervention
		Baseline Measures			Post Intervention Measures			BaselineMeasures			Post Intervention Measures			
		N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	
														superior to solo, p=0.05
Yílmaz et al. (2003)	BDI	14	10.43	6.0	14	6.07	7.45	14	7.29	5.41		6.21	4.92	No significant difference
Mental Health														
Bravo et al. (1996)	Psychological Well-being (Dupuy, 1978)	61	73.38	14.74		80.98	16.13	36	71.78	15.64				No significant difference, p=0.57
Cakit et al. (2010)	SF-36	14	35.0	19.6	14	42.2	22.7	10	23.0	19.5	10	26.0	25.3	No significant difference
Cecchi et al., 2009	SF-36	25	48.1	16.9				25	50.0	19.7				No significant difference
King et al. (2002)	SF-36	42	77.7	16.0	27	77.5	16.2	42	79.2	15.7	27	84.6	12.4	No significant difference, p=0.3
Reeder et al. (2008)	SF-12	73	50.3		73	53.2	7.39	80.0	50.7		80	51.9	6.68	Group physical activity significantly superior to solo, $t(151)=2.58$, $p=0.01$
Regensteiner et al. (1997)	SF-20	10	67.0	13.0	10	65.0	22.0	10	57.0	27.0	10	54.0	26.0	No significant difference, $t(18) = 1.02$, $p=0.32$
Solak et al. (2008)	SF-36	30	20.0	3.8	30	21.8	3.7	30	19.4	4.05	30	19.8	4.08	No significant difference, p=0.30
Wu et al. (2010)	SF-36	20	78.8	14.4	20	85.0	11.9	22	80.5	14.7	22	80.3	8.0	No significant difference, p=0.31

2.13 **Synthesis of Results**

No studies reported finding solo physical activity significantly superior to group activity in reducing all measure of psychological distress, therefore study outcomes were dichotomised into studies that found group physical activity significantly superior to solo in the reduction of psychological distress (n=7: Analay et al., 2003; Atousa, 2009; Cakit et al., 2010; Neuberger et al., 2007; Reeder et al., 2008; Solak et al., 2008; Timonen et al., 2002) and studies that found no significant difference between conditions (n=15: Blumenthal et al., 2007; Bravo et al., 1996; Cakit et al., 2010; Cecchiet al., 2009; Evcik et al., 2008; Giallauria et al., 2006; Hsieh et al., 2009; King, Taylor & Haskell, 1993; King et al., 2002; McGale, McArdle & Gaffney, 2011; Neuberger et al., 2007; Regensteiner et al., 1997; Solak et al.,2008; Wu et al., 2010; Yilmaz et al., 2003). Three studies featured in both categories as they included more than one measure of psychological distress with conflicting findings (i.e. group was significantly superior to solo in reducing psychological distress for one measure, but not the other; Cakit et al., 2010; Neuberger et al., 2007; Solak et al., 2008).

A summary of study characteristics are presented below (Table 2.6) with a comparison between studies that found group physical activity significantly superior to solo in the reduction of psychological distress and studies that found no significant difference between conditions.

When studies were ordered by assessed quality, those that found a significant difference between group and solo physical activity conditions were interspersed throughout and there was no clear discernible pattern linking study quality and study outcome. However there were some differences in intensity of physical activity prescription, baseline psychological distress and attrition. Adequate assessment of criteria items resulted in a score of 24 (Table 2.4). Only five of the included studies achieved this, two of these five (including Analay et al., 2003; Neuberger et al., 2007) found group significantly superior to solo in the reduction of depression. The remaining three studies found no significant difference between conditions for mental health (Cecchi et al., 2009; King et al., 2002) or depression (Blumenthal et al., 2007).

All studies excluding four, included participants who were minimally or mildly distressed. Bravo et al. (1996) included moderately depressed participants in the solo condition only, with mildly depressed participants in the group. Cakit et al.'s (2010) participants allocated to the group condition were moderately depressed, whereas participants in the solo condition were severely depressed. Neuberger et al. (2007) included participants who were quite pessimistic and moderately distressed. Regensteiner et al.'s (1997) participants were more distressed than those from Carver, Chapman, Thomas, Stadnyk, and Rockwood's (1999) study of a similar age range. Of these four studies, Cakit et al. (2010) was the only to find group physical activity significantly superior to solo physical activity in the reduction of psychological distress.

The lack of congruence in intensity of physical activities between conditions in studies that found group physical activity significantly superior to solo in reducing in psychological distress, appear to be related to two studies. One study did not provide sufficient information to assign an accurate MET score estimation (Atousa et al., 2009) and another prescribed vigorous activity to participants in the group physical activity condition, but a moderate intensity to those in the solo physical activity condition (Cakit et al., 2010). While the majority of studies that found no significant difference between conditions prescribed similar physical activity intensities, two studies that lacked congruence between intensities of physical activity prescribed group-based moderate intensity physical activity and solo-based vigorous physical activity (Evcik et al., 2008; Hsieh et al., 2009).

All studies reported no significant differences between group and solo physical activity conditions baseline psychological distress measures. However, studies that found no significant difference between conditions were more likely to feature baseline measures within half of one standard deviation of each condition than studies that found group significantly superior to solo. Three studies did not provide sufficient information to determine if baseline measures between conditions were within one standard deviation of each other. One of these found no significant differences between conditions (Evcik et al., 2008), two of the studies found group significantly superior to solo in reducing psychological distress (Reeder et al., 2008; Solak et al, 2008). One study that found group significantly superior to solo included baseline measures between conditions that were more than one standard deviation apart (Cakit et al., 2010), with depression being greater for those allocated to the solo physical activity condition.

Attrition was more likely to be well matched between conditions in studies that found no significant difference than those that found group physical activity significantly superior. Of the seven studies that found group significantly superior to solo, two studies did not provide sufficient information to determine attrition rates. One did not report attrition (Atousa, 2009) and the other reported that all the participants completed the exercise, but it is unclear if this refers to adherence solely or to attrition (Solak et al., 2008). Of the other two studies that reported dissimilar attrition from the conditions, one study reported a greater rate for those allocated to the solo physical activity condition (Cakit et al., 2010) and the other reported a greater rate of attrition from the group (Timonen et al., 2002). Cakit et al. (2010) did not report utilising ITT analysis, however Timonen et al. (2002) did, which may have adjusted for bias. Of the studies that found no significant differences between conditions, two studies did not provide sufficient information for group and solo physical activity attrition to be calculated. Of the two studies that included dissimilar attrition from group and solo physical activity conditions, one reported a greater rate of attrition from group physical activity (Bravo et al., 1995) whiles the other reported greater attrition from the solo physical activity condition (Wu et al., 2010).

There were insufficient comparator studies to further examine anxiety (as no studies found group significantly superior to solo physical activity in reducing anxiety) and mental health (as only one study found group significantly superior to solo in improving mental health versus seven that found no significant difference).

Table 2.6 Characteristics of All Studies Comparing Psychological Distress Finding Group Physical Activity Significantly Superior to Solo and Studies Finding No Significant Differences

	Group physical activity significantly superior to solo in reducing psychological distress				No significant difference between group and solo conditions in reducing psychological distress			
	N of Studies	Mean	Median	SD	N of Studies	Mean	Median	SD
Age	6	55.08	55.70	16.81	15	55.67	55.90	13.50
Males (%)	6	23.40	13.38	32.90	13	33.36	25.00	34.73
Females (%)	6	76.61	86.62	32.90	13	66.64	75.00	34.73
Attrition from Group Physical Activity Condition (%)	6	7.83	6.55	8.79	11	12.75	13.33	12.24
Attrition from Solo Physical Activity Condition (%)	6	4.97	4.17	5.52	11	12.25	5.66	16.63
Frequency of Group Physical Activity (Per Week)	7	2.86	3.00	1.07	15	2.87	3.00	0.74
Frequency of Solo Physical Activity (Per Week)	7	2.86	3.00	1.07	14	2.93	3.00	0.73
Session Duration of Group Physical Activity (Mins)	7	61.07	60.00	22.54	15	51.83	60.00	12.90
Session Duration of Solo Physical Activity (Mins)	7	61.79	60.00	21.64	14	50.54	57.50	11.19
Total volume of Group Physical Activity (Mins)	7	1434.29	1800.00	715.47	15	2711.67	1440.00	2903.21
Total volume of Solo Physical Activity (Mins)	7	1445.00	1800.00	699.98	15	2812.67	1440.00	3076.70
N in group exercise	3	6.33	5.50	2.36	8	9.19	8.75	4.28
Additional Educational/ Informational Interventions	1				3			
Additional Support/ Counselling Interventions	2				2			
Additional Unsupervised Socialisation Intervention	1				1			

2.13.1 Depression

Three studies found group significantly superior to solo in reducing depression and four studies found no significant differences (Table 2.5). To further examine depression, a median split of the total assessment score was used to focus on studies with better study quality and less bias. This resulted in six studies (Table 2.7), one of which included two measures of depression and found group was significantly superior to solo in reducing depression when measured using the CES-D, but found no significant difference when using the depression component from the POMS (Neuberger et al., 2007). A further two studies found group significantly superior to solo in the reduction of depression (Timonen et al., 2002; Analay et al., 2003) and four that found no significant difference between conditions (Blumenthal et al., 2007; King et al., 1993; McGale et al., 2011; Neuberger et al., 2007).

Studies that found no significant difference between group and solo physical activity conditions in reducing depression were assessed as having slightly better methodological and reduced risk of bias than studies that found group significantly superior to solo. There appeared to be a small difference in adherence between the two groups of studies, however this incongruence between assessment scores can be explained by one study who did not report adherence (Analay et al., 2003). Two of the studies that found group significantly superior to solo in reducing depression included small sample sizes (Analay et al., 2003; Timonen et al., 2002), whereas only one that found no significant difference between conditions had a small sample size (McGale et al., 2011).

Table 2.7 Characteristics of Studies Comparing Depression of Low Risk of Bias as Identified Through Median Split

	Group physical activity significantly superior to solo in reducing depression				No significant difference between group and solo conditions in reducing depression			
	Studies	Mean	Median	SD	Studies	Mean	Median	SD
Age	3	58.17	55.50	23.66	4	48.27	54.00	13.32
Males (%)	2	42.22	42.22	59.71	3	59.77	54.30	37.80
Females (%)	2	57.78	57.78	59.71	3	40.23	45.70	37.80
Attrition from Group Physical Activity Condition (%)	3	11.29	14.81	10.00	3	20.93	19.61	2.79
Attrition from Solo Physical Activity Condition (%)	3	6.52	8.33	5.83	3	10.57	11.24	4.61
Frequency of Group Physical Activity (Per Week)	3	2.67	3.00	0.58	4	2.75	3.00	0.50
Frequency of Solo Physical Activity (Per Week)	3	2.67	3.00	0.58	4	2.75	3.00	0.50
Session Duration of Group Physical Activity (Mins)	3	69.17	60.00	18.09	4	55.00	57.50	7.07
Session Duration of Solo Physical Activity (Mins)	3	69.17	60.00	18.09	4	55.00	57.50	7.07
Total volume of Group Physical Activity (Mins)	3	1665.00	1800.00	574.52	4	3515.00	2160.00	3453.01
Total volume of Solo Physical Activity (Mins)	3	1665.00	1800.00	574.52	4	3515.00	2160.00	3453.01
N in group exercise	2	5.00	5.00	0.71	1	8.50	8.50	
Additional Educational/ Informational Interventions	0				1			
Additional Support/ Counselling Interventions	0				0			
Additional Unsupervised Socialisation Intervention	1				1			

2.14 **Discussion**

The purpose of this systematic review was to establish if group or solo physical activity was more effective in the reduction of psychological distress. Group physical activity was found to be significantly superior to solo in reducing psychological distress in seven studies, the remaining 15 studies found no significant differences between conditions. However the majority of studies, even when sampling for psychological distress included minimal or mild psychological distress.

Only one meta-analysis has examined a similar dichotomy of group versus solo physical activity in relation to psychological distress, which included measures addressing depression anxiety, stress and quality of life (Burke et al., 2006). The findings of the current review were similar to Burke et al.'s (2006) meta-analysis, which found the collective physical activity condition was (not significantly) superior to the home-based physical activity condition in improving quality of life. However, Burke et al.'s (2006) search strategy failed to identify 2 studies would be applicable from including and before 2006 that were included in the current review (and 6 that were excluded from the current review based on dissimilar total minutes of physical activity, see A4). In addition the current review identified an additional 12 studies after 2006, providing a further update to the evidence. The current review provides more distinct findings than Burke et al. (2006) by investigating anxiety, depression, and mental health separately, and as a total of psychological distress.

2.14.1 Quality of studies

The majority of studies did not adequately address study quality criteria (including a mean score of >24 throughout quality criteria items) and were therefore poor quality. A limitation found both in Conn's (2010a;2010b) meta-analyses was the inclusion of both randomised and non-randomised studies, as non randomisation may lead to self selection bias. In the current review only one study did not randomise participants to conditions and found no significant difference in the reduction of psychological distress between group and solo physical activity conditions (Giallauria et al., 2006). However, individuals who are willing to be randomised may introduce hidden biases which may limit generalisability (Britton, McKee, Black, McPherson, Sanderson, & Bain, 1998). In real world scenarios without prescription from a health professional, individuals will engage in the most appealing type of physical activity. Further research would benefit from understanding these decisions to support promotion of physical activity, especially group physical activity.

Blinding and concealment was inadequately performed by about half of the included studies, which is a criticism also stated by Lawlor and Hopker (2001) in their review of studies over ten years ago. Adequate concealment from group and solo physical activity conditions for instructors and participants is impossible, but bias could be reduced by ensuring assessors and research staff are blind. The majority of studies included small sample sizes, which may have limited the chance of detecting a true effect, but also may have reduced the likelihood that a significant result reflects a true effect (Button, Ioannidis, Mokrysz, Nosek, Flint, Robinson & Munafò, 2013). Studies unaffected by this include Blumenthal (2007 measuring depression); King et al (1993), measuring anxiety and depression); and King et al. (2002); (measuring mental health) who found no significant difference in psychological distress between group and solo physical activity conditions and Neuberger et al. (2007) and Reeder et al. (2008) who found group significantly superior to solo physical activity in reducing depression and mental health, respectively.

Half the studies reported dissimilar attrition between group and solo physical activity, with greater attrition from the group physical activity condition. This may be because it is easier to remain in a study by maintaining minimal involvement in solo physical activity than group (Blumenthal et al., 2007). The dissimilar attrition may have contributed to selection bias which may create prognostic differences in conditions influencing overall findings (Gupta, 2011). ITT analysis provides an unbiased estimate of treatment effect (Wertz, 1995; Montori & Guyatt, 2001; Heritier, Gebski, & Keech, 2003) by including all participants in the groups to which they were assigned, regardless of their adherence or attrition (Fisher, Dixon, Herson, Frankowski, Hearron & Peace, 1989; Gupta, 2011). Of the studies that included dissimilar attrition between conditions only two reported use of ITT analysis

(Timonen et al., 2002; Wu et al., 2010). Throughout the included studies seven used ITT analysis, a similar critique of studies made by Lawlor and Hopker (2001).

All studies reported no significant differences between psychological distress measures at baseline; only three studies reported baseline measures were more than one standard deviation between conditions. The one study that provided sufficient information to determine that baseline psychological distress between conditions was within one standard deviation found group was significantly superior to solo in reducing depression. However, the level of depression for participants in the solo physical activity condition was classified as severe on the BDI scale, while the depression level of participants in the group condition was moderate. Participants in the solo physical activity condition may not have engaged in enough physical activity to benefit from the therapeutic effect as adherence was lower for these individuals (60%) than those in the group physical activity condition (93%). Average adherence was greater for group physical activity participation (71.54%) than solo (66.76%), however this was only based on 11 studies. Participation in solo physical activity may have been lower than this due to demand characteristics and the lack of independent verification.

Conn's (2010) review found supervised, verified physical activity was related to greater anxiolytic effects than unsupervised physical activity which suggests that compliance is an important contribution to the therapeutic effect of physical activity. Two studies within the current review (Giallauria et al., 2006; Wu, et al., 2010) included a monitored and supervised solo condition where participants' physical activity was measured objectively. These conditions were not included in the review as they did not represent a direct comparison of group and solo physical activity. However the authors found that using monitor devices rendered the outcomes comparable to the group activity condition. This is an important implication as participants may not be exercising to the prescribed intensity of activity. In addition, the self-report nature of solo physical activity may incur social desirability bias. Both group and solo physical activity may lead to researcher bias, where participants may try to conform to expectations of research and delivery staff. This may be especially true for participants engaging in physical activity as part of treatment for illness, and may not be generalisable to real life situations engaged in by healthy individuals.

The majority of studies provided similar interventional programmes to participants in both conditions. Six studies provided dissimilar interventions (in addition to physical activity) but there was no predominant targeting to group or solo conditions and there appeared to be no clear confound effect. Physical activity intensity may be an important construct to evaluate in further research. Of the studies that prescribed dissimilar physical activity intensities between group and solo conditions, the one that found group significantly superior to solo prescribed vigorous activity to participants in the group physical activity condition, but a moderate intensity to those in the solo physical activity condition (Cakit et al., 2010). Of the studies that found no significant difference between conditions prescribed group-based moderate intensity physical activity and solo-based vigorous physical activity (Evcik et al., 2008; Hsieh et al., 2009).

Six studies reported follow-up post intervention. Of these two studies that found group significantly superior to solo in reducing depression reported the significant difference persisted at 12-week follow-up (Analay et al., 2003; Timonen et al., 2002). Of the remaining four studies that reported no significant difference between group and solo physical activity conditions, at follow-up there was still no significant difference between conditions (Blumenthal et al., 2007; Cecchi et al., 2009; Evcik et al., 2008, McGale et al., 2011).

2.14.2 Depression

The review was only able to adequately compare studies that found group significantly superior to solo and studies that found no significant difference for depression. There were no comparators for studies that measured anxiety as all studies found no significant differences between group and solo physical activity conditions. This may suggest that group physical activity is not part of the anti-anxiety mechanism, or that the therapeutic effect is reduced by social or presentation anxiety. Further research is required to confirm the equal effectiveness of group and solo physical activity in reducing anxiety. Likewise, there were no comparators for the study that measured stress. One study was excluded from analysis as total minutes of group and solo physical activity were not within 20% of each other (Erdman & Duivenvoorden, 1983). Both studies that measured stress found no significant difference between conditions in reducing stress, however as with anxiety further investigation is required to confirm or reject those findings.

Conn's (2010b) review reported that interventions delivered to groups and individuals were equally effective in reducing depression which is somewhat supported in the current review as six studies found no significant difference between group and solo physical activity conditions. However, eight studies found group physical activity was significantly superior to solo in the reduction of depression. Although the "floor effect" suggests healthy individuals may have a poorer capacity for improvement than those with clinical depression (Pinquart, Duberstein & Lyness, 2007), the majority of studies included minimal or mild psychological distress. Therefore the results of this review may not relate to moderate or severe psychological distress but may be useful for informing the promotion of physical activity to reduce psychological distress in the general population.

The earlier issues identified with the assessment of bias were reduced in these studies. Mean attrition of group physical activity was greater than solo in studies that found no significant difference in the reduction of depression between group and solo physical activity conditions and studies that found group significantly superior to solo. As previously described, this may introduce selection bias. Further research is required to investigate if this is related to greater barriers to group physical activity than solo. While mean frequency and session duration was highly similar between group and solo conditions in all studies, studies that found group significantly superior to solo reported shorter intervention periods than studies that found no significant difference between conditions. This may suggest that the anti-depressant effect of physical activity is achieved faster when exercising in a group, as the anti-depressant effect may take longer to achieve when exercising alone. Two studies that found group significantly superior to solo in reducing depression reported a smaller exercise group (5 people) compared to the study that found no significant difference (mean=8.5 people). This may suggest that smaller groups are more coherent and thus more likely to promote adherence, but more research is required to confirm this since so few studies reported exercise group size.

The anti-depressant mechanisms may be related to an increase the availability of neurotransmitters, and cerebral blood flow (Deslandes, et al., 2009); release of endogenous opiates neurogenesis, enhanced CNS metabolism and angiogenesis (Cotman, et al., 2007), and exercise-driven changes in the hypothalamic–pituitary–adrenal axis (Nabkasorn, et al., 2006). Social contact or support may enhance these mechanisms and offer a potential explanation as to why group physical activity was significantly superior to group in the reduction of depression. For example, Brosse, Sheets, Lett and Blumenthal (2002) suggest physical activity can attenuate the HPA axis response to stressors thus promoting psychological well-being. Social support has been associated with a reduced neuroendocrine reactivity to social stressors (Eisenberger, Taylor, Gable, Hilmert & Liberman, 2007) which may support the effect of physical activity on the HPA axis response. The psychological mechanisms described earlier such as the promotion of self-efficacy and self-esteem (Fox, 2000; Taylor & Fox, 2005), sense of mastery (Bandura, 1986), and distraction from negative affect (Bahrke & Morgan, 1978) and be enhanced by a socially minded instructor and group dynamic to boost satisfaction and enjoyment (Rejeski & Mihalko, 2001).

2.14.3 Strengths and limitations

The major limitation of this review was study quality, with only five studies adequately addressing quality criteria sufficiently. The current review was restricted to articles published in English. A limited number of electronic databases were included within the search and a necessarily finite number of search terms were explored, all of which may have inadvertently excluded potentially relevant studies. Often physical activity interventions were described ambiguously, making it difficult to distinguish between one-on-one supervised and group-based physical activity interventions. A number of ambiguities were resolved through contact with authors; however this was not the case for a small number of studies. In addition, specific activities were not part of the search strategy such as “football” or “tennis”, which also may have failed to identify eligible studies.

Conn (2010a; 2010b) criticised previous reviews for combining diverse mental health outcomes together such as depression and anxiety. The current review not only considers psychological distress as a combination of mood related dimensions, but also considered depression separately.

a) Sample

Previous reviews were criticised for pooling samples with both mental and physical health problems (Lawlor & Hopker, 2001). Due to the limited number of studies available, it is currently not possible to conduct a review comparing group and solo physical activity in healthy individuals only. There were only two studies which contained samples free from mental or physical illness which satisfied the inclusion criteria (King, Taylor & Haskell, 1993; McGale, McArdle, & Gaffney, 2011). Both found no significant difference between group and solo physical activity in the reduction of psychological distress.

Clinical populations may have different motivations to non-clinical. Clinical populations may be motivated to initiate or maintain physical activity behaviour by expecting or experiencing improvement in physical functioning or management of physical symptoms. In addition, group activities may offer participants with similar illnesses increased social support and shared information, thus promoting engagement.

The majority of interventions within the review were not designed to reduce psychological distress. Furthermore the majority of studies did not sample participants based on their psychological distress. Two studies sampled participants for depression, and one of these contained clinically diagnosed depression (Atousa, 2009; Blumenthal et al., 2007).

b) Physical Activity

Within studies there were a variety of different types of physical activity (for example resistance, aerobic, or flexibility exercise), often multiple types per exercise session, therefore it was not possible to categorise and compare different types of physical activity. However, the type of activity may not be an important contributor to the therapeutic effect of group compared with solo physical activity. For example, there was no significant difference between running and weight lifting in reducing depression (Ossip-Klein et al., 1989) or between aerobic and non-aerobic activity in reducing depression and dysthymia (Martinsen, Hoffart & Solberg, 1989). Likewise no optimal form of activity has been identified to reduce anxiety (Scully et al., 1998). The current review finds that a variety of physical activity types can elicit a therapeutic effect in reducing psychological distress.

c) Contact/Instructor Characteristics

There was an obvious systemic bias in contact with staff for members of the group physical activity conditions. No studies attempted to control for the social interaction effect of the group activity condition, but some did include regular phone calls to members of the solo physical activity condition to provide motivation and information. This may have led to social desirability and research biases, as participants may have felt the need to conform to expectations of the researchers in solo physical activity conditions.

Burke et al. (2006) found the beneficial effects of interventions were improved by contact with research staff and physical activity instructors. The current review cannot offer a similar comparison as it does not include meta-analysis methodology; however the frequency of contact with staff was recorded. There did not appear to be a clear influence of contact in relation to the difference between group and solo physical activity conditions as the frequency of contact was more similar in studies that found group significantly superior to solo than in studies that found no significant difference between conditions. However the measure of contact was very arbitrary. Future studies would benefit from specifying the exact kind, frequency, duration of contact with both group and solo physical activity conditions. Although, this confound is not applicable to understanding engagement in physical activity by the general population.

Instructor characteristics were another potential confound that have affected the effectiveness of the group physical activity interventions. However some studies endeavoured to use the same trainer/experimenter to deliver the physical activity intervention which may have controlled for the issue, but the majority did not report on the characteristics or approaches of physical activity instructors.

2.14.4 Future studies

Future research should provide adequate concealment and blinding, follow-up period, intention to treat analysis, randomisation, and identical prescribed physical activity where possible including MET intensity scoring, similar contact between group and solo physical conditions and awareness of instructor leadership style. The efficacy of group physical activity in reducing depression is much clearer than anxiety, stress or mental health, with the latter requiring further investigation. Psychological benefits are unlikely to persist without sustaining physical activity, therefore understanding adherence to group and solo physical activity would be beneficial. Likewise, further studies are needed to examine adherence of solo physical activity prescription in comparison to group when using objective monitoring devices. Understanding the mechanisms behind group and solo physical activity may be useful in the promotion of physical activity, especially to populations who would benefit the most, such as the clinically depressed.

2.15 **Conclusion**

This review provides some support to the superiority of the group context in the reduction of depression. The applicability of this finding may be important when prescribing exercise to patients with low mood. While solo physical activity may appear as a low cost intervention this review justifies the further investigation or application of group physical activity in attaining improvements in depression.

Chapter 3

Group Versus Solo Physical Activity Preferences; Benefits and Barriers

3.1 Introduction

The physical and psychological benefits of physical activity have been well established. Warbuton, Nicol and Bredin's (2006) review strongly indicated that physical activity is related to the primary and secondary prevention of several chronic diseases such as cardiovascular disease, diabetes, cancer, obesity and osteoporosis. This relationship appears to be curvilinear, with the increase in benefits becoming less for any given increase in the amount of physical activity (Physical Activity Guidelines Committee, 2008). For example, Lee and Paffenberger (1998) found a decreased risk of stroke in men was observed at energy expenditures of 1000 to 1999 kcal/wk, with further reduction at 2000 to 2999 kcal/wk but not beyond. Inactive individuals benefit the most from increasing their physical activity level (Pate, et al., 1995), and even minimal adherence compared with non-adherence to physical activity recommendations have be associated with decreased all-cause mortality rates and observable benefit (Lee & Skerrett, 2001; Kushi, Fee and Folsom, 1997; Leon, Connett and Jacobs, 1987; Paffenbarger, Hyde and Wing, 1993). Mental health benefits have been found when engaging in as little as 20 minutes per week of any kind of physical activity (Hamer & Chida, 2009), but greater volumes of physical activity were associated with increased mental health.

The current physical activity recommendations for physical health (including cardiorespiratory and muscular fitness, bone health and risk reduction of non-communicable disease such as cardiovascular disease, diabetes and cancer and their risk factors such as raised blood pressure, raised blood sugar and being overweight) suggest individuals should be active daily, engage in moderate physical activity for a minimum of 150 minutes per week (accumulated in bouts of at least 10 minutes per session), or engage in 75 minutes of vigorous activity per week (or a combination of vigorous and moderate), engage in activities that strengthen muscles at least twice per week and limit extended periods of sedentary activity (World Health Organisation, 2010). Previous recommended levels of physical activity for health benefits include an accumulation of 30 minutes or more of moderate-intensity physical activity five days per week, or 20 minutes of vigorous activity three days per week (Pate et al., 1995). The latter recommendation is supported for improvement of mild to moderate depression (Dunn, 2005; WHO, 2010) and anxiety (Petruzzello, Landers, Hatfield, Kubitz & Salazar, 1991; Herring, O'Connor & Dishman, 2010). Wipfli, Rethorst and Landers (2008) found the benefits of physical activity on anxiety may be achievable with a lower dose. No optimal dose of physical activity has been defined for the reduction of stress, however Berger (1986) Berger and Owen (1983) and Scully, Kremer, Meade, Graham and Dudgeon (1998) suggest a duration of 20 to 30 minutes of physical activity per session with intensity to elevate heart rate significantly above resting pulse. However concordance with these recommendations is poor for both adults of the general population and university students.

Despite the benefits of physical activity, a large proportion of individuals do not meet the recommended levels. The Scottish Health Survey from 2012 (Scottish Government, 2014) interviewed 4,807 members of the Scottish population and found only 62% of adults met physical activity recommended levels. This is an improvement on a previous survey conducted in 2010 (Scottish Government, 2011) where 39% of individuals did not meet physical activity recommendations. However this may be due to a change in recommendations structure. To meet physical activity recommendations, participants were not required to engage in moderate physical activity five days per week or vigorous on three (the former recommendation, Pate et al. 1995), but were allowed to accumulate 150 minutes of moderate intensity, or 75 minutes of vigorous intensity physical activity over a week (as per recent recommendations from the World Health Organisation, 2010). Likewise, the National Active Student Survey (NASS, British Universities and College Sport and Leisure-net Solutions, 2007) with a sample of 22,000 students from 110 UK institutions reported that only 23% met Pate et al.,'s (1995) physical activity recommendations, 48% of students engaged in three 30 minute sessions of moderate intensity activity per week, the remaining 29% engaged in less per week. As physical activity levels appear to decrease when individuals leave school (Bauman, Owen, & Rushworth,1990; Owen & Bauman, 1992; U. S. Department of Health & Human Services, 1996; Douglas, Collins, Warren, Kann, Gold, Clayton, Ross & Kolbe, 1997), it is important to promote physical activity to university students and young adults to support lifelong activity.

Different contexts of physical activity may be more beneficial for mental health and well-being than others. In Burke, Carron, Eys, Ntoumanis and Estabrooks's (2006) systematic review and meta-analysis, group physical activity (employing team building exercises to encourage cohesion) was found to be significantly superior to standard group exercise classes, which in turn were significantly superior to solo physical activity with no contact (from researchers or health-care professionals) in relation to enhancing adherence (including self-report and objective attendance), social interaction, quality of life, physiological effectiveness and functional effectiveness. In relation to quality of life (including depression, anxiety, stress, behavioural or emotional control, psychological well-being and other measures of physical functioning which included psychological well-being related items), there were no differences between group exercise classes and solo physical activity with contact (from researchers or health-care professionals), but group exercise classes were superior to solo physical activity without contact, although differences were not significant. In addition, the systematic review in the current thesis (Chapter 2) found some support that group physical activity was superior to solo in the reduction of psychological distress. There were no significant differences between conditions for anxiety and there were inadequate studies available to provide a comparison of group versus solo physical activity for stress.

These findings highlight the importance of contact with others in promoting quality of life, which may be facilitated by adherence. Burke et al. (2006) found adherence was significantly superior in true groups over standard exercise classes and in group exercise classes over solo physical activity without contact. However adherence was similar between group exercise classes and solo physical activity with contact, but authors suggest this may have been related to similar levels of support received by participants. In naturalistic settings individuals are more likely to experience contact from others in groups unless they have been referred for physical activity by a health professional. It may be more sustainable to promote group physical activity than solo in order to promote adherence and better attain the benefits of quality of life.

To promote or develop interventions to encourage group physical activity it is important to understand an individual's preferences for engaging in group and solo physical activity, including the reasoning for doing so (relating to the perceived benefits and barriers of an action), especially in an inactive or low active population. Perceived barriers maybe the most influential belief system affecting behaviour change (Finfgeld, Wongvatunyu. Conn, Grando & Russell, 2003) while positive beliefs regarding the health benefits of exercise are the most often reported reason for engaging in exercise (Steinhardt & Dishman, 1989). However only two studies have investigated adults' preference of physical activity intervention delivery context and neither investigated the perceived benefits and barriers of the contexts of physical activity. Burton, Asaduzzaman Khan and Brown (2012) found adults (aged 40 to 67) preferred physical activity they could do alone and not in team-based activities. Sixty five percent of participants met recommended levels of physical activity if not more, with 22% engaging in a low level physical activity and 12% engaging no physical activity at all. However differences in preferences between inactive, low and adequately active individuals were not presented. Short, Vandelanotte and Duncan (2014) found no significant difference in the percentage of adults engaging in sufficient physical activity (as defined by Pate et al., 1995, previously) between preferences of physical activity intervention including face-to-face, group-based, print, and web-based. While neither study investigated perceived benefits and barriers of group versus solo physical activity, Burton et al. (2012) suggested that their participants may have encountered general barriers to physical activity such as cost, including membership fees, associated resources (such as appropriate clothing), and indirect costs (including travel). They suggest the preference for solo physical activity may be related to a reduced reliance on others, reduced difficulties in scheduling and shared access to facilities and reduced negative social comparisons with others and the benefits of group based activities include social support and structure (such as the shared responsibility of motivation or routine).

There appears to be no study that assesses the group and solo physical activity preferences of inactive or low active young adults or university students. Burke, Carron and Eys (2006) sampled students from a kinesiology undergraduate course where sport and exercise-related activities were compulsory and found university students preferred group physical activity to solo. The female students preferred unstructured group activity followed by structured classes, physical activity alone in an exercise setting and completely alone. The male students preferred unstructured group physical activity followed by engaging in physical activity alone but in an exercise setting completely alone and finally a structured class. Further investigation is required to establish the group and solo physical activity preferences of inactive or low active university students. The students were also asked to indicate in one or two sentences the reasoning for their preferences on the four physical activity contexts (Shapcott, Burke, Carron & Eys, 2007). Males and females reported unstructured group physical activity provided them opportunities for personal control, increased motivation and the presence of friends. The most frequently cited barriers female students encountered when exercising alone was difficulties staying motivated, adhering and boredom. Male students' least preferred activity was structured exercise settings and reported this was due to a lack of personal control and the possibility of comparison. However, these findings included only active participants and they may not reflect inactive individuals' perceptions of benefits and barriers to physical activity.

There is scarce evidence relating to the benefits and barriers of group versus solo physical activity. No study has quantitatively compared the benefits and barriers of engaging in either group versus solo physical activity. Freene, Waddington, Chesworth, Davey and Cochrane (2014) conducted focus groups of community-dwelling adults aged between 50 and 65 year olds after participation in self-selected group and home-based interventions and reported that there were greater barriers to group physical activity than solo. Group specific barriers included low self-efficacy, lack of enjoyment, and inflexible schedule due to other commitments such as caring for others. However others expressed that the group physical activity was enjoyable and that they benefited from the social support. The home-based included short telephone calls which were considered beneficial by participants, with one participant stating they would not have completed the intervention without it. Home-based specific barriers were limited, but activity was facilitated by flexible scheduling. These findings are limited to home-based physical activity and cannot be generalised entirely to solo physical activity.

Despite the benefits of physical activity a large proportion of individuals do not currently meet physical activity guidelines (Scottish Government, 2014). Burke et al.'s (2006) meta-analysis and the findings from Chapter 2 provide some support that group physical activity may be more beneficial than solo in promoting psychological well-being. The current study will investigate if this relationship can be found in naturalistic population. Despite the potential benefits of group physical activity, there is little evidence on whether inactive or low active individuals prefer group or solo physical activity and the benefits or barriers they experience. The Benefits and Barriers of Group Versus Solo Physical Activity measure was developed to quantitatively investigate the differences in benefits and barriers of group versus solo physical activity of active and inactive individuals and potentially support the development of a future physical activity intervention. Currently there are no scales that address the reasoning as to why an individual may prefer group or solo physical activity over the other, instead they address items which can apply to both group and solo physical activity such as "exercising helps me sleep better at night" or "I am fatigued by exercise" (EBBS, Sechrist et al., 1987). The current study investigated the relationship physical activity and psychological distress (including stress, depression and anxiety) in an adult general population and student survey. Subsequently, it investigated the preferences, benefits and barriers of group versus solo physical activity of low, moderately and highly active individuals from a student and adult population.

3.1.1 Research Questions

In population samples (including the general population and a student population) does increased particpation in group physical activity relate to lower levels of psychological distress than participation in solo physical activity?

Do less active individuals perceive greater barriers and fewer benefits to group physical activity compared with solo?

Do less active individuals prefer solo physical activities over group?

3.2 Methods

3.2.1 Participants and Sample Recruitment

Two samples were recruited from the community and from a student population. The current study was designed to inform an intervention study and to hopefully provide access to participants for this. Particiapnts were asked in the questionnaire is they would be willing to participate in a future intervention. The community sample was recruited first but due to the low response rate of indivudals willing to participate in an intervention, the current study was repeated in a student population.

a) Sample 1 (Community)

Participants were randomly sampled from the general population of three council wards in Edinburgh to represent a variety of socio-economic groups. The wards were identified from the Scottish Index of Multiple Deprivation (Scottish Government, 2003). In order of descending socio-economic status these wards are: Marchmont, Portobello and Craigmillar. Craigmillar ranked the most deprived area in Edinburgh, and was ranked 4th out of 1,222 wards in Scotland. Portobello ranked 29th out of 58 wards in Edinburgh, while Marchmont was the least deprived ward in Edinburgh ranking 1,221st out of 1,222 wards overall in Scotland.

The General Register Office for Scotland (2007) found a hand delivered census survey in Glasgow to a similar population as the current study reported a 49.5% response rate (35.6% in deprived areas). Panter, Jonesa, Hillsdon (2008) found a 45% rate in a similar survey requesting information on physical activity in England. This was an average response rate across different levels of socioeconomic deprivation, with a 21.2% response rate in the most deprived area. Therefore for the current study it was estimated that there would be a 30% response rate for the Edinburgh wards overall. Power calculations derived from Green (1991) required at least 98 participants for multiple regression analysis. Therefore recruitment aimed to achieve this number of responses.

Four hundred and sixty house numbers were selected with a random number generator. On delivery of questionnaires if residences were discovered vacant or demolished, questionnaires were relabelled and delivered to a different random address from the same ward.

However due to a poor return rate, 600 more addresses were included. Therefore 220 questionnaires were sent to Marchmont, 420 to Portobello and 420 to Craigmillar. Reminder letters and packs were delivered to these addresses 4–6 weeks after the initial contact. Overall 144 questionnaires were returned (13.58% return rate), however 18 of these were labelled "uncompleted" as less than 10% of the pack was completed by the respondent (Table 3.1). From a total of 126 viable questionnaires, 52 were from Marchmont, 50 from Portobello and 22 from Craigmillar (Table 3.2).

Participants received an invitation to participate containing information about the study and questionnaire pack (see Appendix B2). Individuals opted to participate by completing the questionnaire pack and returning it. Consent was assumed if questionnaires were returned, as no signatures or names were collected this ensured participant's anonymity. Participants under the age of 18 were excluded from taking part.

Table 3.1 Frequency of Responses from Wards

Ward	Response	n	%
Highest SES Ward (Marchmont)	Uncompleted	1	1.9
	Replied First Time	36	67.9
	Replied With Reminder	16	30.2
	Total	53	100.0
Mid SES Ward (Portobello)	Uncompleted	15	23.1
	Replied First Time	39	60.0
	Replied With Reminder	11	16.9
	Total	65	100.0
Lowest SES Ward (Craigmillar)	Uncompleted	2	7.7
	Replied First Time	20	76.9
	Replied With Reminder	4	15.4

Total	26	100.0

Table 3.2 Ward Response Rates

	Highest SES Ward (Marchmont) (%)	Mid SES Ward (Portobello) (%)	Lowest SES Ward (Craigmillar) (%)	All Wards (%)
Response Rate Before Reminder	16.36	9.29	4.76	8.96
Total Response Rate After Reminder	23.64	11.90	5.71	11.89
Total Response Rate Including Uncompleted responses	24.09	15.48	6.19	13.58

The overall mean age for participants was 47.58 (SD=15.71), participants from Marchmont had the lowest mean age (M=43.67, SD=15.46), followed by Craigmillar (M=44.62, SD=14.60) and Portobello (M=52.58, SD=15.29). More females than males completed the questionnaire in all wards (Table 3). Most participants were married or co-habited throughout wards. Most participants in Craigmillar and Marchmont did not have any children; however in Portobello over a third of respondents had two children. Most participants throughout wards were full-time employed. In Marchmont and Portobello a greater number of participants had undergraduate or undergraduate and postgraduate degrees. However in Craigmillar, 29.17% of participants held school level qualifications, followed by 20% holding an undergraduate degree. The mean socioeconomic status of participants was 5.16 (SD=3.59, Mdn = 4.10) of a sample of 95, the remaining 31 participants declined to respond. Despite being chosen for its lower socioeconomic status, participants from Craigmillar reported the most professional and technical occupations (M = 4.55, SD = 3.97, n = 18) followed by Portobello (M = 4.95, SD=2.95, n= 39) and Marchmont (M = 5.67, SD=4.02, n = 38). The wards showed similar medians (ranging from 4.05 for Craigmillar to 4.10 for Portobello and Marchmont) representing lower professional and higher technical occupations (National Statistics, 2005).

Table 3.3 Demographics of Community Survey Participants

		Highest SES Ward (Marchmont)		Mid SES WArd (Portobello)		Lowest SES Ward (Craigmillar)		Total Responses	
		n	%	N	%	n	%	N	%
	Participants	52	41.27	50	39.68	24	19.05	126	100.00
Sex	Males	21	40.38	19	38.00	4	16.67	44	34.92
	Females	30	57.69	31	62.00	20	83.33	81	64.29
Marital status	Single	12	23.08	12	24.00	9	37.50	33	26.19
	Married/Co-Habiting	26	50.00	23	46.00	10	41.67	59	46.83
	In a relationship	1	1.92	3	6.00	3	12.50	7	5.56
	Widowed	2	3.85	7	14.00	2	8.33	11	8.73
Child Status	No Children	22	42.31	12	24.00	11	45.83	45	35.71
	1 Child	4	7.69	7	14.00	1	4.17	12	9.52
	2 Children	10	19.23	18	36.00	7	29.17	35	27.78
	3 Children or More	6	11.54	7	14.00	5	20.83	18	14.29
Employment Status	Unemployed	0	0.00	3	6.00	5	20.83	8	6.35
	Student	4	7.69	0	0.00	0	0.00	4	3.17
	Full-Time	25	48.08	23	46.00	16	66.67	64	50.79
	Part-Time	10	19.23	6	12.00	1	4.17	17	13.49
	Retired	3	5.77	13	26.00	2	8.33	18	14.29
Education	None	0	0.00	1	2.00	0	0.00	1	0.79
	School (GCSE/O-Levels)	6	11.54	9	18.00	7	29.17	22	17.46
	College (A-Levels/Vocational Studies)	11	21.15	8	16.00	2	8.33	21	16.67
	Undergraduate Degree	14	26.92	10	20.00	6	25.00	30	23.81
	Postgraduate Degree	7	13.46	10	20.00	2	8.33	19	15.08
	Other	4	7.69	5	10.00	5	20.83	14	11.11

Procedure

Addresses were randomly sampled using the method described earlier. Council Ward Maps from the Scottish Government were used to identify ward boundaries (these can be found in Appendix C). Phillip's Street Map of Edinburgh (2003) was used to identify residential street addresses. Random.org was the random number generator used to identify house numbers (www.random.org). All participants received a letter of invitation to take part in the current study which was presented in the first page of the questionnaire pack, a participant information sheet detailing the nature of the study and a questionnaire pack and a stamped addressed envelope. Each questionnaire pack and address was marked with a unique identification code. Questionnaires were hand delivered to these addresses. Questionnaire packs were returned in stamped addressed envelopes to the university. Data was entered into SPSS 14.

b) Sample 2 (Student)

Several methods were used to recruit student participants including leaflets, posters and virtual advertisements. Six hundred leaflets were distributed to students throughout university campus areas (see Appendix E1). Two hundred and forty posters were placed in communal student areas, with tear off strips detailing the email address and website for the study (see Appendix E2).

An email advertising the study was sent to students of the School of Philosophy, Psychology and Language Sciences and the School of Health including details of the study and contact information. Advertisements were placed in online communities specific to Edinburgh, such as the official Student Union online message boards, and a general Edinburgh messageboard (Gumtree.co.uk). An advert was placed on an online blogging site (Livejournal.com) which contains several communities specific to students and Edinburgh residents. Finally, an advert was placed on Facebook (an online networking and communication website), designed to display to individuals at the University of Edinburgh which resulted in 389 responses. However, it was not possible to track how many of these individuals went on to complete the questionnaire.

As with Study 1 (Community Survey), students received an invitation to participate containing information about the study and questionnaire pack (see Appendix B3 and B4). Consent forms were not necessary as consent was assumed if questionnaires were returned or completed. Participants from the current study were excluded if they were not students from the University of Edinburgh. To encourage participation there was a £20 cash prize draw incentive.

Overall, 511 individuals responded to the questionnaire. Nine responses were excluded as they were not students from the University of Edinburgh and a further 55 responses were excluded as less than 10% of the questionnaire was completed, resulting in a total of 447 completed questionnaires. The mean age was 22.20 (SD=4.71) based on 415 responses, the remaining 32 declined to answer. There were 153 males and 293 females, 1 respondent chose not to disclose their sex. The mean socioeconomic status of participants or their parents (based on the highest classified occupation) was 3.85 (SD=2.44) of a sample of 351. Occupations rated 3 relate to higher professional occupations (National Statistics, 2005). The majority of participants were first and second year undergraduates (Table 3.4), were single (Table 3.5) and had no children (Table 3.6).

Table 3.4 University Status

Degree Status		n	%
Undergraduate	Year 1	76	17.00
	Year 2	90	20.13
	Year 3	57	12.75
	Year 4	61	13.65
Postgraduate	Masters Degree	41	9.17
	PhD	35	7.83
	Total Responses	360	80.54
	Chose not to disclose	87	19.46

Table 3.5 Relationship Status

Relationship Status	n	%
Single	216	48.3
In a relationship	177	39.6
Married/Co-habiting	48	10.7
Chose not to disclose	6	1.3

Table 3.6 Number of Children

Child Status	n	%
No Children	422	94.4
1 Child	15	3.4
2 Children	5	1.1

3 or more children	2	0.4
Chose not to disclose	3	0.7

Procedure

Participants were opportunely sampled using the methods previously described. A link to an online version of the questionnaire was advertised through posters, flyers, email and posted in various internet communities and social networking sites. The online version was designed and maintained at www.surveymonkey.com. Each response was marked with a unique identification code to ensure anonymity. Data was then entered into SPSS 14.

c) Measures

The questionnaire pack for the community sample comprised the following measures (See Appendix B1) in order as below. The student questionnaire pack contained the same measures excluding the hopelessness single item and a tailored demographic questionnaire for students.

Demographic Questionnaire

This comprised seven items to gather information on age, sex, marital status, education and socioeconomic status. Socioeconomic status was derived from occupation which was graded using the National Statistics Socio-economic Classification (Rose, University of Essex, Great Britain, & Economic and Social Research Council, 2005). Two items requested weight and height, in order to determine BMI, this was not essential to analysis, but may have been used in a future intervention study.

International Physical Activity Questionnaire Short Version (IPAQ-Short; Booth, 2000)

This questionnaire was chosen due to its good psychometric properties, extensive use in other studies, short length, and use of Metabolic Equivalents (METs).

Using 7-items, the IPAQ addresses the type, frequency, intensity, and duration of activity in the past week, including a question listing the numbers of hours spent sitting (e.g. “During the last 7 days, on how many days did you walk for at least 10 minutes at a time?”). The IPAQ can be scored in different ways and the current study used it to calculate METs for continuous data and to enable comparisons with other studies.

Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth, Pratt, Ekelund, Yngve, Sallis, Oja (2003)’s review demonstrated the acceptable validity and reliability of the IPAQ across twelve countries and comparability with other measures. The authors reported no difference between short and long forms (pooled p, for comparisons between long and short forms was 0.67, 95% CI 0.64–0.70). In addition, the short version was the preferred form from sites which received both versions. The criterion validity of the IPAQ against CSA accelerometers shows a fair to moderate agreement for both the long version ($N = 744$, pooled $p = 0.33$, 95% CI 0.26–0.39) and short ($N = 781$, pooled $p = 0.30$, 95% CI 0.23–0.36). The test-retest reliability of the short form was acceptable, with 75% of the correlation coefficients observed above 0.65 and ranging from 0.88 to 0.32.

A number of measures of physical activity were considered, these can be found in A5 along with their reasons for exclusion. The IPAQ was chosen as it is a robust, compact measure.

Metabolic Equivalent (MET)

Metabolic equivalent is a measure of effort used by the body and can be used to estimate the intensity of physical activities. The metabolic equivalent (MET) represents a procedure for expressing the energy cost of physical activities as multiples of average resting metabolic rate (Bryne, Hills, Hunter, Weinsier and Schutz, 2005). Resting metabolic rate is the minimum number of calories the body needs to support its basic physiological functions.

Ainsworth, Haskell, Whitt, Irwin, Swartz, Strath, O'Brien, Bassett, Schmitz, Emplaincourt, Jacobs and Leon (2000) has described an extensive compendium of physical activities in terms of MET scores. For example, 1 MET is equivalent to the energy used by a person sitting quietly, whereas doubles tennis has been assigned a value of five METs. Therefore, the greater effort expended, the higher the MET score.

Ainsworth et al. (2000) stresses that the compendium was not developed to determine the precise energy cost of physical activity. Moy, Scragg, McLean, and Carr (2006) explains that MET scores were designed to facilitate coding of physical activities from multiple sources such as questionnaires, interviews, diaries or logs. Balady (2002) describes the particular advantage of using MET scores in research as they provide a common descriptor of activities for use in all populations which allows ease of comparison.

Benefits and Barriers to Exercise Questionnaire (BBE; Myers & Roth, 1997)

This is a 48-item scale measuring perceived benefits (24 items; e.g. “It provides me with a way to meet people”) and barriers (24 items; e.g. “It is too much work for me”) to exercise. Each item is rating along a 5-point Likert scale, with responses ranging from “strongly agree” to “strongly disagree”. The original word “exercise” from Myers and Roth’s (1997) questionnaire was changed to “physical activity” in the current study to reduce negative word association noted at piloting.

The questionnaire was developed for young adults (although the questions are appropriate to all adults below retirement age), based on a measure of benefits and barriers by Steinhardt and Dishman (1989). The measure is designed to be used as a two-factor model (as benefits and barriers) opposed to a one-factor (one singular benefit and barrier score). Only a minimal correlation was observed between benefits and barriers ($r= 0.06$), the authors conclude perceived benefits were not correlated with perceived barriers. The authors report that test-retest reliability was greater for benefit score ($r = 0.88$) than barrier score ($r = 0.68$). Overall, test-retest reliabilities of individual benefit and barrier subscale scores ranged from 0.60 to 0.86.

However authors report an eight-factor model containing four benefit factors (social, psychological, body image and health) and four barrier factors (time-effort, physical effects, social and specific obstacles) may also be used due to good fit with data.

The questionnaire was supplemented by two benefit items and ten barriers items which examined other areas than the BEE, such as identity, “I am not the sporty type”, which were included to inform a future intervention study. These items were not included in the analysis of the Benefits and Barriers to Exercise Questionnaire.

Stages of Change Questionnaire

Participants selected one statement from 5-items relating their willingness to engage with physical activity, for example “I currently exercise or participate in some physical activity, but not regularly”. The statements used were based on those developed by Marcus, Rakowski, and Rossi (1992) and recommended by Reed, Velicer, Prochaska, Rossi, and Marcus (1997), in which participants chose the most applicable statement out of 5 possible choices. Marcus et al.’s (1992) measure demonstrated reported excellent test-retest reliability over two-weeks (kappa index 0.78) and concurrent validity with a seven-day physical activity recall questionnaire (Marcus & Simkin, 1993).

One criticism is that Marcus et al. (1992) did not define "exercise" to their participants. In the current study the terms "exercise" and "physical activity" have been used and throughout the questionnaire pack and defined as "any kind of physical activity, playing sports, going on walks, going to the gym, dance or exercise classes". This questionnaire was included with the intention of further use informing a future intervention study. It did not feature in the current study hypotheses or analysis.

Subjective Norm (Ajzen, 2002)

Subjective norm is a construct used in the Theory of Planned Behaviour (Ajzen, 1991). It is defined as the expectation of opinions of others who are important to an individual and also the degree to which the individual is inclined to agree or comply with these (Vries, Dijkstra, & Kuhlman, 1988). Basically, it represents the influence of others' expectations on the individual.

Ajzen (2002) recommends that subjective norm items be presented with descriptive norm items as often responses to subjective norms have low variability. Descriptive norms are described as the behaviour of others surrounding the individual. An example of a subjective norm item; "Most people who are important to me think that I should participate in some form of physical activity."An example of the descriptive norm item; "Most people who are important to me participate in some form of physical activity".

Participants were first asked to indicate who in their life was important to them from a list (or define other). Subsequently, participants responded to 6-items in total (3-items relating to subjective norms, three-items relating to descriptive norms) with a 5-point Likert scale ranging from "strongly agree" to "strongly disagree".

Depression Anxiety Stress Scale, Short Version (DASS-21, based on the full version of the DASS, Lovibond & Lovibond, 1995)

The DASS-21 consists of 21-items, containing three 7-item self-report scales taken from the full version of the DASS (Lovibond & Lovibond, 1995) measuring depression, anxiety and stress. A 4-point severity scale measures the extent to which each state has been experienced over the past week (ranging from "did not apply to me at all" to "applied to me most of the time").

Henry and Crawford (2005) have concluded the psychometric properties of this scale were acceptable in a large nonclinical population. They also conclude that the measure can be used as a singular measure of psychological distress or as three dimensions including stress, anxiety and depression. The internal consistencies were good for total DASS-21 score ($\alpha = 0.93$, 95% CI 0.93–0.94), depression scale ($\alpha = 0.88$, 95% CI 0.87–0.89), anxiety scale ($\alpha = 0.82$, 95% CI 0.80–0.83), stress scale ($\alpha = 0.90$, 95% CI 0.89–0.91). Likewise, Henry and Crawford (2006) report that the DASS-21 shows good convergent and discriminant validity when compared with other validated measures of depression and anxiety, such as the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983), and the Personal Disturbance Scale (Bedford, Foulds, & Sheffield, 1976).

One question from the Beck Depression Inventory (BDI-II) representing hopelessness, supplemented the DASS-21 in the current study. This was not included in the analysis including the DASS-21 but was retained to inform a future intervention study.

Social Phobia Inventory, Short Version (Mini-SPIN, Connor, Kobak, Churchill, Katzelnick, & Davidson, 2001)

This is a brief three-item scale measuring social phobia. A fife-point severity scale ranging from "not at all" to "extremely" measures the extent to which each state has been experienced over the past week. An example from the Mini-SPIN is "I avoid activities in which I am the centre of attention". This measure was developed from the Social Phobia Inventory (SPIN, Connor et al., 2000), a 17-item self-rated assessment of social phobia.

Connor, et al. (1999) concluded that the Mini-SPIN demonstrates good psychometric properties supporting its utility as a screening tool for social phobia. In their evaluation, they report this measure had a sensitivity of 88.7%, a specificity of 90.0%, a positive predictive value of 52.5%, and negative predictive value of 98.5%. They conclude that this measure replicates social phobia prevalence rates to that reported in the US National Comorbidity Survey (Kessler, McGonagle, Zhao, Nelson, Hughes, Eshleman, Wittchen & Kendler, 1994).

This measure was included with the intention of informing a future intervention study. It did not feature in the current study hypotheses or analysis.

Activity Context Preference

Participants were requested to state their preference for either group or solo physical activity. Two items were presented on a five-point Likert scale ranging from "strongly agree" to "strongly disagree". The solo preference item was "I would rather do physical activity alone”. The group preference item was “I would rather do physical activity with others or in a group”.

Ability Level Preference

A single item question asked participants if they would rather engage with physical activity with others who are of the same ability on a 5- point Likert scale ranging from “strongly agree” to “strongly disagree”.

This questionnaire was included with the intention of informing a future intervention study, as it may be important to match those of similar abilities to groups. It did not feature in the current study hypotheses or analysis.

Participation in Group and Solo Activity

Two questions requested details of current participation in group and solo activities. Further questions request type of activity, frequency and duration. Participants were also asked to detail past activities that they no longer engaged in, along with a reason for them terminating this activity. As with the International Physical Activity Questionnaire, these responses can be scored using METs as described earlier, to ensure comparability.

Benefits and Barriers of Group Versus Solo Physical Activity Scale

Four scales were designed to specifically examine the pros and cons of being active as part of a group or alone consisting of 20 items in total. ve items related to the pros of group physical activity, and five to the pros of solo activity. A further five item relate to the cons of group, and cons of physical activity alone. It was presented with a five- point Likert scale ranging from “strongly agree” to “strongly disagree”. The following items such as “most people in sports groups play at a higher standard than me”, “committing to a group would make it more likely that I would attend” or “I would rather learn from about physical activities from taking part with others, than learning through reading” addresses specific concerns regarding the group that general benefit or barrier questionnaires neglect. Likewise, items were selected to further examine issues related to exercising alone such as “I might feel silly exercising on my own” and “I can concentrate without being interrupted by others”. These items were developed through discussions with supervisors and consideration of items found in the EBBS (Sechrist et al., 1987) and the BBE (Myers & Roth, 1997) on considering reasons why individuals would prefer group or solo physical activity. Qualitative studies by Freene et al. (2014) and Shapcott, et al. (2007) did not inform item generation as the current measure was developed in 2007 before publication of these studies.

Group physical activity was defined as “two or more people who know each other, participating in physical activity or exercising together” and solo physical activity was defined as “doing physical activity alone”.. The Flesch-Kincaid Reading Ease rating of the total scale was 79.5, which corresponds to secondary school reading level and is acceptable for consumer-oriented information (Bernstam, Shelton, Walji & Meric-Bernstam, 2004).

Principal component analysis (PCA) was used to investigate the underlying factor structure by summarising the data into a fewer number of components (Fabrigar, Wegener, MacCallum & Strahan, 1999). Determining the number of factors to retain is the most crucial problem when interpreting findings from PCA, parallel analysis is a method which has been found to be consistently accurate in determining the threshold for significant components (Franklin et al., 1995), therefore parallel analysis was used to confirm the number of factors indicated by PCA (Ledesma & Valero-Mora, 2007). Cronbach’s alpha was used to assess internal consistency both for the total scale and scales.

Table 3.7 List of Items Created for the Benefits and Barriers of Group versus Solo Physical Activity (BBGS)

Subscale	No	Item
Barriers of Group Physical Activity	1	I would not know how to find or approach a group
	2	Others would want me to be competitive, and I do not wish to be
	3	I do not want to be obligated or committed to a group
	4	I would be concerned of how I might look
	5	Most people in sports groups play at a higher standard than me
Benefits of Group Physical Activity	6	The encouragement from others would motivate me
	7	I would enjoy meeting others in a group
	8	I would enjoy making friends
	9	Committing to a group would make it more likely that I would attend
	10	I would rather learn about physical activities from taking part with others, than learning through reading
Barriers of Solo Physical Activity	11	I would be worried about injuring myself
	12	I might not be doing it right
	13	I might be afraid of exercising alone
	14	I might feel silly exercising on my own
	15	I would be less motivated without the company of others
Benefits of Solo Physical Activity	16	Alone, I can go at my own pace
	17	I can participate when I want to, without having made arrangements with others
	18	I can set my own goals
	19	I can concentrate without being interrupted by others
	20	I don’t have to talk to anyone

Means and standard deviations for all items and scales for both samples are reported below (Table 3.8, Table 3.9). Factor Analysis was conducted to examine the underlying factor structure of the BBGS. The assumptions for factor analysis were met as both samples included an adequate sample size and acceptable factorability of the correlation matrix.

Table 3.8 Mean and Standard Deviations of BBGS of All Items and Scales in Community Sample

Scale	No	Item	N	Mean	SD
Barriers of Group Physical Activity	1	I would not know how to find or approach a group	124	2.52	1.35
	2	Others would want me to be competitive, and I do not wish to be	124	2.70	1.34
	3	I do not want to be obligated or committed to a group	124	3.10	1.31
	4	I would be concerned of how I might look	124	2.25	1.34
	5	Most people in sports groups play at a higher standard than me	124	3.15	1.35
Benefits of Group Physical Activity	6	The encouragement from others would motivate me	124	3.62	1.07
	7	I would enjoy meeting others in a group	124	3.85	0.97
	8	I would enjoy making friends	123	3.93	0.97
	9	Committing to a group would make it more likely that I would attend	123	3.64	0.98
	10	I would rather learn about physical activities from taking part with others, than learning through reading	123	3.88	1.06
Barriers of Solo Physical Activity	11	I would be worried about injuring myself	122	2.33	1.23
	12	I might not be doing it right	122	2.60	1.28
	13	I might be afraid of exercising alone	122	2.00	1.08
	14	I might feel silly exercising on my own	122	1.91	1.08
	15	I would be less motivated without the company of others	122	2.96	1.38
Benefits of Solo Physical Activity	16	Alone, I can go at my own pace	122	3.96	1.02
	17	I can participate when I want to, without having made arrangements with others	122	3.93	1.05
	18	I can set my own goals	122	4.04	1.00
	19	I can concentrate without being interrupted by others	122	3.81	1.12
	20	I don’t have to talk to anyone	122	3.21	1.14

Barriers of Group Physical Activity	124	13.72	4.85
Benefits of Group Physical Activity	123	18.93	4.27
Barriers of Solo Physical Activity	122	11.80	4.40
Benefits of Solo Physical Activity	122	18.95	4.38

Table 3.9 Mean and Standard Deviations of BBGS of All Items and Scales in Student Sample

Scale	No	Item	N	Mean	SD
Barriers of Group Physical Activity	1	I would not know how to find or approach a group	299	2.47	1.26
	2	Others would want me to be competitive, and I do not wish to be	299	2.79	1.33
	3	I do not want to be obligated or committed to a group	299	3.16	1.28
	4	I would be concerned of how I might look	299	2.97	1.37
	5	Most people in sports groups play at a higher standard than me	299	3.47	1.30
Benefits of Group Physical Activity	6	The encouragement from others would motivate me	299	3.90	0.98
	7	I would enjoy meeting others in a group	299	4.14	0.88
	8	I would enjoy making friends	299	4.24	0.84
	9	Committing to a group would make it more likely that I would attend	299	3.79	1.02
	10	I would rather learn about physical activities from taking part with others, than learning through reading	299	4.00	1.06
Barriers of Solo Physical Activity	11	I would be worried about injuring myself	293	2.16	1.19
	12	I might not be doing it right	293	2.94	1.19
	13	I might be afraid of exercising alone	293	1.76	0.99
	14	I might feel silly exercising on my own	293	2.06	1.22
	15	I would be less motivated without the company of others	293	2.84	1.29
Benefits of Solo Physical Activity	16	Alone, I can go at my own pace	293	4.23	0.78
	17	I can participate when I want to, without having made arrangements with others	293	4.29	0.79
	18	I can set my own goals	293	4.28	0.72
	19	I can concentrate without being interrupted by others	293	4.04	0.97
	20	I don’t have to talk to anyone	293	3.49	1.17

Barriers of Group Physical Activity	298	14.84	4.61
Benefits of Group Physical Activity	298	20.07	3.64
Barriers of Solo Physical Activity	292	11.77	3.81
Benefits of Solo Physical Activity	292	20.32	3.42

The Kaiser-Meyer-Olkin value was 0.75 for the community sample and 0.78 for the student, exceeding the recommended value of 0.6 (Kaiser, 1970, 1974) and the Bartlett's Test of Sphericity (Bartlett, 1954) reached statistical significant supporting the factorability of the correlation matrix for both the community sample (X^2 [190] = 1343.84, $p<0.01$) and the student (X^2 [190] = 2125.82, $p<0.01$).

Principal component analysis revealed the presence of five components with eigenvalues exceeding 1 in both samples, explaining 4.10%, 3.78%, 3.39%, 1.68% and 1.01% of the variance for the community sample and 4.27%, 2.94%, 2.62%, 1.29% and 1.10% for the student sample. Inspection of the screeplots revealed a break after the fourth component in both samples (Appendix F1 and F2). The unrotated loadings can be found in Appendix A6 and A7.

Parallel analysis was conducted to determine the number of factors to retain for further examination. It revealed four components with eigenvalues exceeding the corresponding criterion values in both community and student samples (Table 3.10).

Table 3.10 Number of Components Revealed by Parallel Analysis

Sample	Component Number	Actual Eigenvalue from PCA	Criterion Value From Parallel Analysis	Decision
Community	1	4.101	1.803	Accept
	2	3.778	1.642	Accept
	3	3.389	1.526	Accept
	4	1.677	1.427	Accept
	5	1.013	1.339	Reject
	6	0.889	1.256	Reject
Student	1	4.266	1.492	Accept
	2	2.938	1.400	Accept
	3	2.623	1.332	Accept
	4	1.294	1.273	Accept
	5	1.103	1.220	Reject
	6	0.888	1.173	Reject

A further principal component analysis with varimax rotation that specified a four component solution explained a total of 64.73% of the variance for the community sample with component 1 contributing 18.88%, component 2, 18.28%, component 3, 13.87% and component 4, 13.69% (Table 3.11). The four component solution explained a total of 55.60% of the variance for the student sample, with component 1 contributing 16.07%, component two, 15.52%, component three, 13.19%, and component four 10.82% (Table 3.12).

Both samples generally supported the four component solution, with each item loading on the correct subscale. However Item 3 "I do not want to be obligated or committed to a group", Item 12 "I might not be doing it right", and Item 15 "I would be less motivated without the company of others" were excluded from final subscales as items loaded on multiple components (Table 3.11, 3.12).

Table 3.11 Community Sample Varimax Rotation of Four Factor Solution for BBGS

Sub-Scale	Item		Component 1 Group Benefits	Component 2 Solo Benefits	Component 3 Solo Barriers	Component 4 Group Barriers
Benefits of Group Physical Activity	8	I would enjoy making friends	.922	.013	-.024	.004
	7	I would enjoy meeting others in a group	.905	-.092	.054	-.047
	9	Committing to a group would make it more likely that I would attend	.858	.057	.022	.024
	10	I would rather learn about physical activities from taking part with others, than learning through reading	.780	.003	-.007	.004
	6	The encouragement from others would motivate me	.761	-.008	.045	.138
Benefits of Solo Physical Activity	17	I can participate when I want to, without having made arrangements with others	-.040	.883	-.071	-.012
	16	Alone, I can go at my own pace	.045	.874	-.064	.050
	18	I can set my own goals	.128	.873	-.038	-.035
	19	I can concentrate without being interrupted by others	-.042	.842	-.002	.087
	20	I don't have to talk to anyone	-.090	.640	.176	.034
Barriers of Solo Physical Activity	13	I might be afraid of exercising alone	-.010	-.059	.884	-.004
	12	I might not be doing it right	-.008	-.020	.749	.291
	14	I might feel silly exercising on my own	-.080	-.047	.739	.185
	11	I would be worried about injuring myself	.072	.229	.703	.130
	15	I would be less motivated without the company of others	.313	-.104	.454	.212
Barriers of Group Physical Activity	4	I would be concerned of how I might look	.018	.001	.242	.783
	5	Most people in sports groups play at a higher standard than me	.109	-.031	.139	.756
	2	Others would want me to be competitive, and I do not wish to be	.012	-.021	.217	.737
	1	I would not know how to find or approach a group	.086	.031	.101	.671
	3	I do not want to be obligated or committed to a group	-.157	.385	-.042	.586
		% of the variance explained	18.88	18.28	13.87	13.69

Table 3.12 Student Sample Varimax Rotation of Four Factor Solution for BBGS

Sub-Scale	Item		Component			
			1 Group Benefits	2 Solo Benefits	3 Solo Barriers	4 Group Barriers
Benefits of Group Physical Activity	8	I would enjoy making friends	.886	-.068	-.007	-.093
	7	I would enjoy meeting others in a group	.856	-.076	-.136	.008
	6	The encouragement from others would motivate me	.745	-.017	-.039	.113
	9	Committing to a group would make it more likely that I would attend	.613	-.187	-.223	.176
	10	I would rather learn about physical activities from taking part with others, than learning through reading	.606	-.005	-.179	.077
Benefits of Solo Physical Activity	19	I can concentrate without being interrupted by others	-.117	.823	-.006	-.049
	17	I can participate when I want to, without having made arrangements with others	-.015	.815	.131	.018
	16	Alone, I can go at my own pace	.034	.800	.139	-.024
	18	I can set my own goals	-.003	.796	-.011	-.055
	20	I don't have to talk to anyone	-.268	.583	.112	-.105
Barriers of Group Physical Activity	5	Most people in sports groups play at a higher standard than me	-.009	.120	.773	.124
	2	Others would want me to be competitive, and I do not wish to be	-.166	.021	.726	-.019
	4	I would be concerned of how I might look	-.072	.014	.683	.245
	3	I do not want to be obligated or committed to a group	-.206	.177	.658	-.113
	1	I would not know how to find or approach a group	-.119	.026	.536	.262
Barriers of Solo Physical Activity	13	I might be afraid of exercising alone	-.062	-.047	.131	.788
	14	I might feel silly exercising on my own	-.032	-.100	.203	.705
	11	I would be worried about injuring myself	.087	-.015	.020	.583
	15	I would be less motivated without the company of others	.336	-.135	-.069	.504
	12	I might not be doing it right	.308	.154	.336	.470
		% of the variance explained	16.07	15.52	13.19	10.82

Cronbach's alphas for benefits of group and solo physical activity for community and student samples were considered very good (according to Devellis, 2012, p.109; Table 3.13). Cronbach's alphas for barriers to group and solo physical activity within the community sample and cons to group within the student sample were considered respectable. The Cronbach's alpha for barriers of solo physical activity was acceptable within the community sample, but undesirable within the student sample. Item 11 "I would be worried about injuring myself" was excluded from the subscale which improved the alpha from undesirable to minimally acceptable in the student sample (0.67, Table 3.14). This resulted in four items included in the Barriers of Group Physical Activity subscale, five items in the Benefits of Group Physical Activity subscale, 2 items in the Barriers of Solo Physical Activity subscale and 5 items in the Benefits of Solo Physical Activity subscale.

A noncentral mean, poor variability, negative correlation among items, weak inter-item correlations and low item-scale correlations will reduce alpha (DeVellis, 2012, p.108) and were therefore inspected. Inspection of mean centrality for both community and student samples indicated the benefits of group and solo physical activity were negatively skewed (Table 3.15, 3.16). In both samples barriers to solo physical activity was moderately skewed. Univariate kurtosis and skewness statistics were within acceptable ranges for both samples (kurtosis <7, skewness <2, West, Finch & Curran, 1995). All items demonstrated a range of responses between 1 and 5 for both samples, demonstrated positive and acceptable strength correlations among all items (Table 3.17), and acceptable item-scale correlations (Table 3.18).

Table 3.13 Cronbach's Alphas for Subscales for both Community and Student Samples

Subscale	Community Sample	Student Sample	Number of Items
Barriers of Group Physical Activity	0.78	0.72	4
Benefits of Group Physical Activity	0.90	0.82	5
Barriers of Solo Physical Activity	0.72	0.60	3
Benefits of Solo Physical Activity	0.88	0.82	5

Table 3.14 Community and Student Sample Corrected Item-Total Correlation and Improvement in Subscale Cronbach's Alpha if Item Deleted

Subscales	Item	Corrected Item-Total Correlation		Cronbach's Alpha if Item Deleted	
		Community Sample	Student Sample	Community Sample	Student Sample
Barriers of Group Physical Activity	1	0.48	0.41	0.78	0.71
	2	0.61	0.51	0.71	0.65
	4	0.66	0.53	0.69	0.63
	5	0.59	0.56	0.72	0.62
Sub-scale Cronbach's Alpha Including All Items				0.78	0.72
Benefits of Group Physical Activity	6	0.68	0.61	0.90	0.78
	7	0.84	0.73	0.87	0.75
	8	0.85	0.73	0.86	0.75
	9	0.77	0.53	0.88	0.81
	10	0.67	0.49	0.90	0.82
Sub-scale Cronbach's Alpha Including All Items				0.90	0.82
Barriers of Solo Physical Activity	11	0.43	0.30	0.79	0.67
	13	0.70	0.57	0.45	0.30
	14	0.53	0.40	0.65	0.52
Sub-scale Cronbach's Alpha Including All Items				0.72	0.60
Benefits of Solo Physical Activity	16	0.79	0.64	0.84	0.77
	17	0.78	0.69	0.84	0.76
	18	0.79	0.62	0.84	0.78
	19	0.75	0.70	0.85	0.75
	20	0.50	0.49	0.91	0.84
Sub-scale Cronbach's Alpha Including All Items				0.88	0.82

Table 3.15 Community Sample Means, Medians, SDs, Skewness and Kurtosis

Subscale	No	Item	N	Mean	Mdn	SD	Skewness	Skewness SE	Kurtosis	Kurtosis SE
Barriers of Group Physical Activity	1	I would not know how to find or approach a group	124	2.52	2.0	1.35	0.40	0.22	-1.09	0.43
	2	Others would want me to be competitive, and I do not wish to be	124	2.70	3.0	1.34	0.17	0.22	-1.18	0.43
	4	I would be concerned of how I might look	124	2.25	2.0	1.34	0.66	0.22	-0.87	0.43
	5	Most people in sports groups play at a higher standard than me	124	3.15	3.0	1.35	-0.25	0.22	-1.09	0.43
Benefits of Group Physical Activity	6	The encouragement from others would motivate me	124	3.62	4.0	1.07	-0.80	0.22	0.48	0.43
	7	I would enjoy meeting others in a group	124	3.85	4.0	0.97	-0.85	0.22	0.78	0.43
	8	I would enjoy making friends	123	3.93	4.0	0.97	-0.79	0.22	0.48	0.43
	9	Committing to a group would make it more likely that I would attend	123	3.64	4.0	0.98	-0.68	0.22	0.27	0.43
	10	I would rather learn about physical activities from taking part with others, than learning through reading.	123	3.88	4.0	1.06	-0.72	0.22	-0.02	0.43
Barriers of Solo Physical Activity	13	I might be afraid of exercising alone	122	2.00	2.0	1.08	0.71	0.22	-0.52	0.44
	14	I might feel silly exercising on my own	122	1.91	2.0	1.08	0.98	0.22	0.09	0.44
Benefits of Solo Physical Activity	16	Alone, I can go at my own pace	122	3.96	4.0	1.02	-1.12	0.22	1.18	0.44
	17	I can participate when I want to, without having made arrangements with others	122	3.93	4.0	1.05	-1.00	0.22	0.70	0.44
	18	I can set my own goals	122	4.04	4.0	1.00	-1.14	0.22	1.20	0.44
	19	I can concentrate without being interrupted by others	122	3.81	4.0	1.12	-0.96	0.22	0.50	0.44
	20	I don't have to talk to anyone	122	3.21	3.0	1.14	-0.36	0.22	-0.31	0.44
Barriers of Group Physical Activity (4 items)			124	10.62	11.00	4.16	0.20	0.22	-0.70	0.43
Benefits of Group Physical Activity (5 items)			123	18.93	19.0	4.27	-1.02	0.22	1.50	0.43
Barriers of Solo Physical Activity (2 items)			122	3.91	4.0	1.97	0.63	0.22	-0.57	0.44
Benefits of Solo Physical Activity (5 items)			122	18.95	20.0	4.38	-1.00	0.22	1.24	0.44

Table 3.16 Student Sample Means, Medians, SDs, Skewness and Kurtosis

Subscale	No	Item	N	Mean	Mdn	SD	Skewness	Skewness SE	Kurtosis	Kurtosis SE
Barriers of Group Physical Activity	1	I would not know how to find or approach a group	299	2.47	2.00	1.26	0.44	0.14	-0.98	0.28
	2	Others would want me to be competitive, and I do not wish to be	299	2.79	3.00	1.33	0.06	0.14	-1.30	0.28
	4	I would be concerned of how I might look	299	2.97	3.00	1.37	-0.12	0.14	-1.31	0.28
	5	Most people in sports groups play at a higher standard than me	299	3.47	4.00	1.30	-0.56	0.14	-0.76	0.28
Benefits of Group Physical Activity	6	The encouragement from others would motivate me	299	3.90	4.00	0.98	-0.92	0.14	0.58	0.28
	7	I would enjoy meeting others in a group	299	4.14	4.00	0.88	-1.13	0.14	1.29	0.28
	8	I would enjoy making friends	299	4.24	4.00	0.84	-1.22	0.14	1.68	0.28
	9	Committing to a group would make it more likely that I would attend	299	3.79	4.00	1.02	-0.70	0.14	0.03	0.28
	10	I would rather learn about physical activities from taking part with others, than learning through reading.	299	4.00	4.00	1.06	-0.98	0.14	0.52	0.28
Barriers of Solo Physical Activity	13	I might be afraid of exercising alone	293	1.76	1.00	0.99	1.21	0.14	0.80	0.28
	14	I might feel silly exercising on my own	293	2.06	2.00	1.22	0.87	0.14	-0.46	0.28
Benefits of Solo Physical Activity	16	Alone, I can go at my own pace	293	4.23	4.00	0.78	-1.18	0.14	2.34	0.28
	17	I can participate when I want to, without having made arrangements with others	293	4.29	4.00	0.79	-1.40	0.14	3.08	0.28
	18	I can set my own goals	293	4.28	4.00	0.72	-0.92	0.14	1.23	0.28
	19	I can concentrate without being interrupted by others	293	4.04	4.00	0.97	-0.85	0.14	-0.03	0.28
	20	I don’t have to talk to anyone	293	3.49	4.00	1.17	-0.41	0.14	-0.61	0.28
Barriers of Group Physical Activity (4 items)			299	11.70	12.00	3.87	-0.08	0.14	-0.66	0.28
Benefits of Group Physical Activity (5 items)			298	20.07	20.00	3.64	-1.02	0.14	1.55	0.28
Barriers of Solo Physical Activity (2 items)			293	3.83	3.00	1.93	0.91	0.14	0.17	0.28
Benefits of Solo Physical Activity (5 items)			292	20.32	20.00	3.42	-0.59	0.14	0.41	0.28

Table 3.17 Community and Student Sample Item Inter-Correlations

Subscale	Correlations	Community Sample (One-Tailed)	Student Sample (One-Tailed)
Barriers of Group Physical Activity	Item 1 & 2	rs= 0.43**, n=124	rs=0.34**, n=299
	Item 1 & 4	rs= 0.47**, n=124	rs=0.35**, n=299
	Item 1 & 5	rs= 0.31**, n=124	rs=0.29**, n=299
	Item 2 & 4	rs=0.50**, n=124	rs=0.36**, n=299
	Item 2 & 5	rs= 0.54**, n=124	rs=0.46**, n=299
	Item 4 & 5	rs= 0.56**, n=124	rs=0.50**, n=299
Benefits of Group Physical Activity	Item 6 & 7	rs=0.60**, n=124	rs=0.55**, n=299
	Item 6 & 8	rs=0.65**, n=123	rs=0.59**, n=299
	Item 6 & 9	rs=0.56**, n=123	rs=0.42**, n=299
	Item 6 & 10	rs=0.49**, n=123	rs=0.38**, n=299
	Item 7 & 8	rs=0.86**, n=123	rs=0.85**, n=299
	Item 7 & 9	rs=0.67**, n=123	rs=0.48**, n=299
	Item 7 & 10	rs=0.66**, n=123	rs=0.39**, n=299
	Item 8 & 9	rs=0.65**, n=123	rs=0.45**, n=299
	Item 8 & 10	rs=0.55**, n=123	rs=0.42**, n=299
	Item 9 & 10	rs=0.56**, n=123	rs=0.32**, n=299
Barriers of Solo Physical Activity	Item 13 & 14	rs=0.73**, n=122	rs=0.54**, n=293
Benefits of Solo Physical Activity	Item 16 & 17	rs=0.81**, n=122	rs=0.69**, n=293
	Item 16 & 18	rs=0.75**, n=122	rs=0.62**, n=293
	Item 16 & 19	rs=0.60**, n=122	rs=0.57**, n=293
	Item 16 & 20	rs=0.36**, n=122	rs=0.35**, n=293
	Item 17 & 18	rs=0.76**, n=122	rs=0.64**, n=293
	Item 17 & 19	rs=0.61**, n=122	rs=0.63**, n=293
	Item 17 & 20	rs=0.36**, n=122	rs=0.40**, n=293
	Item 18 & 19	rs=0.67**, n=122	rs=0.66**, n=293
	Item 18 & 20	rs=0.41**, n=122	rs=0.36**, n=293
	Item 19 & 20	rs=0.50**, n=122	rs=0.50**, n=293

Table 3.18 Community and Student Sample Correlation of Items with their Subscales

Subscale	Item	Community Sample (One-Tailed)	Student Sample (One-Tailed)
Barriers to Group Physical Activity	1	rs= 0.71**, n=124	rs= 0.65**, n=299
	2	rs=0.79**, n=124	rs= 0.73**, n=299
	4	rs= 0.81**, n=124	rs= 0.76**, n=299
	5	rs= 0.77**, n=124	rs= 0.76**, n=299
Benefits to Group Physical Activity	6	rs= 0.80**, n=123	rs= 0.74**, n=298
	7	rs= 0.88**, n=123	rs= 0.83**, n=298
	8	rs= 0.87**, n=123	rs= 0.82**, n=298
	9	rs= 0.82**, n=123	rs= 0.71**, n=298
	10	rs= 0.75**, n=123	rs= 0.66**, n=298
Barriers to Solo Physical Activity	13	rs= 0.93**, n=122	rs= 0.82**, n=293
	14	rs= 0.92**, n=122	rs= 0.91**, n=293
Benefits to Solo Physical Activity	16	rs= 0.84**, n=122	rs= 0.74**, n=292
	17	rs= 0.85**, n=122	rs= 0.78**, n=292
	18	rs= 0.85**, n=122	rs= 0.76**, n=292
	19	rs= 0.82**, n=122	rs= 0.85**, n=292
	20	rs= 0.67**, n=122	rs= 0.74**, n=292

The scale demonstrated acceptable reliability for use with both samples but would benefit from subsequent development for further use.

d) Data analysis

Respondents were categorised using the International Physical Activity Questionnaire (IPAQ) guidelines as low, moderate or highly active. Low active individuals were those who did not meet criteria to be categorised as moderately or highly active.

Moderately active individuals engaged in either, 3 or more days of vigorous-intensity activity of at least 20 minutes per day; 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day; 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day; or 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET-minutes/week.

Highly active individuals engaged in either, vigorous-intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET-minutes/week; or 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity of at least 3000 MET-minutes/week.

The student sample was weighted using data from the Higher Education Statistics Agency Limited (HESA, 2015) to ensure adequate representation of the UK student population.

Hypothesis 1

a) Greater Levels of Physical Activity Will Be Related to Lower Levels of Psychological Distress

One-tailed correlational analysis measured the association between the two variables; activity level as measured by the IPAQ and psychological distress as measured by DASS.

b) Group Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

c) Solo Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

Levels of group and solo physical activity was measured using MET intensity scores (Ainsworth et al. 2000) The MET intensity score was multiplied by the frequency and duration of an activity which produced an overall score. This group and solo physical activity score was correlated with psychological distress, as measured by the DASS.

<u>Hypothesis 2</u>

a) Low active individuals will perceive greater barriers for engaging in group activity than solo, than moderately or highly active individuals

b) Low active individuals will perceive lesser benefits for engaging in group activity than solo, than moderately or highly active individuals

Barriers to group activity were measured using the Benefits and Barriers of Group Versus Solo Physical Activity Scale (**Error! Reference source not found.**). articipants were categorised as per IPAQ recommendations (see above). Paired-samples t-tests were used to investigate difference between group and solo physical activity. Effect sizes (Cohen's D) were calculated to compare magnitude of effect.

<u>Hypothesis 3</u> - Low active individuals will have a greater preference for solo physical activity than group physical activity than moderately or highly active individuals.

Preference was coded into one categorical variable, including group, solo and equal preference to engage in physical activity. Equal preference was defined by equal Likert scores for group and solo preference. Chi-Square was used to compare differences in physical activity preferences and physical activity levels.

<u>Hypothesis 4</u> - The following factors will be predictive of group and solo physical activity; the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety

Standard multiple regression was used to assess the predictive utility of the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety on group and solo physical activity.

e) Ethics

This project was granted ethical approval by the NHS for the community sample (see Appendix D for this confirmation). Consent forms were not included in the questionnaire pack, as consent was assumed if the participant returned the completed pack. The student sample was granted ethical approval by the Department of Clinical and Health Psychology, University of Edinburgh (see Appendix D for this confirmation). Consent forms were not included in the questionnaire pack, as consent was assumed if the participant returned the completed pack.

3.3 Results

3.3.1 Community sample results

The average age of all participants was 47.58 (SD=15.71) years old, 43.67 (SD=15.46) in Marchmont, 52.58 (SD=15.29) n Portobello and 44.62 (SD=14.60) in Craigmillar, ANOVA indicated a significant difference in age between the three wards ($F[2, 116] = 4.67$, $p=0.01$), with a medium effect size (eta squared = 0.07). Post-hoc comparisons revealed the significant difference in ages was between Marchmont and Portobello. There was not a significant difference in proportion of males and females between the wards (χ^2 [2] = 4.59, $p=0.10$, $n=125$). Other demographic variables could not be assessed with Chi-Square statistics as assumptions concerning the minimum expected cell frequency were violated and not within recommended ranges (Cochrane, 1952, Conover, 1999, p.202).

Table 3.19 Demographic Characteristics of Participants

		Total		Marchmont		Portobello		Craigmillar	
		N	(%)	N	(%)	N	(%)	N	(%)
Sex	Male	44	34.92	21	40.38	19	38.00	4	16.67
	Female	81	64.29	30	57.69	31	62.00	20	83.33
	Total	125	99.21	51	98.08	50	100.00	24	100.00
	No Response	1	0.79	1	1.92				
	Total	126	100.00	52	100.00				
Marital Status	Single	33	26.19	12	23.08	12	24.00	9	37.50
	Married/Co-Habiting	59	46.83	26	50.00	23	46.00	10	41.67
	In a relationship	7	5.56	1	1.92	3	6.00	3	12.50
	Widowed	11	8.73	2	3.85	7	14.00	2	8.33
	Total	110	87.30	41	78.85	45	90.00	24	100.00
	No Response	16	12.70	11	21.15	5	10.00		
	Total	126	100.00	52	100.00	50	100.00		
Number of Children	No Children	45	35.7	22	42.31	12	24.00	11	45.83
	One Child	12	9.5	4	7.69	7	14.00	1	4.17
	Two Children	35	27.8	10	19.23	18	36.00	7	29.17
	Three Children or More	18	14.3	6	11.54	7	14.00	5	20.83
	Total	110	87.3	42	80.77	44	88.00	24	100.00
	No Response	16	12.7	10	19.23	6	12.00		
	Total	126	100.0	52	100.00	50	100.00		
Employment Status	Unemployed	8	6.35	0.00	0.00	3	6.00	5	20.83
	Student	4	3.17	4	7.69	0	0.00	0	0.00
	Full-Time	64	50.79	25	48.08	23	46.00	16	66.67

		Total		Marchmont		Portobello		Craigmillar	
		N	(%)	N	(%)	N	(%)	N	(%)
	Part-Time	17	13.49	10	19.23	6	12.00	1	4.17
	Retired	18	14.29	3	5.77	13	26.00	2	8.33
	Total	111	88.10	42	80.77	45	90.00	24	100.00
	No Response	15	11.90	10	19.23	5	10.00		
	Total	126	100.00	52	100.00	50	100.00		
Total Level of Education	None	1	0.79	0	0.00	1	2.00		
	School (GCSE/O-Levels)	22	17.46	6	11.54	9	18.00	7	29.17
	College (A-Levels/ Vocational Studies)	21	16.67	11	21.15	8	16.00	2	8.33
	Undergraduate Degree	30	23.81	14	26.92	10	20.00	6	25.00
	Postgraduate Degree	19	15.08	7	13.46	10	20.00	2	8.33
	Other	14	11.11	4	7.69	5	10.00	5	20.83
	Total	107	84.92	42	80.77	43	86.00	22	91.67
	No Response	19	15.08	10	19.23	7	14.00	2	8.33
	Total	126	100.00	52	100.00	50	100.00	24	100.00

Hypothesis 1a - Greater Levels of Physical Activity Will Be Related to Lower Levels of Psychological Distress

Hypothesis 1b – Group Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

Hypothesis 1c – Solo Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

There was not a significant correlation between physical activity and depression, anxiety, stress or psychological distress overall (Table 3.20, Table 3.21). There were no significant correlations with solo physical activity and depression, stress, anxiety and psychological distress overall, however there were significant negative small correlations between group physical activity and depression, anxiety, stress and psychological distress overall.

Table 3.20 Means of Physical Activity and Psychological Distress

	M	SD	n
Physical Activity (MET-min/week)	3793.72	3811.74	126
Solo Physical Activity (MET-min/week)	639.45	1087.05	126
Group Physical Activity (MET-min/week)	1050.05	1232.98	126
Depression	2.90	3.73	126
Anxiety	1.98	2.92	126
Stress	4.52	4.42	126
Psychological Distress Overall	9.40	9.81	126

Table 3.21 Correlations of Physical Activity, Group and Solo Physical Activity and Psychological Distress

	Physical Activity (n=126)	Group Physical Activity (n=126)	Solo Physical Activity (n=126)
Depression	R= -0.02, p=0.43	R= -0.20, p=0.01	R= -0.04, p=0.32
Anxiety	R= -0.02, p=0.43	R= -0.18, p=0.02	R= -0.06, p=0.27
Stress	R= -0.07, p=0.23	R= -0.18, p=0.02	R= -0.05, p=0.28
Psychological Distress Overall	R= -0.04, p=0.32	R= -0.21, p=0.01	R= -0.06, p=0.27

Hypothesis 2a – Low active individuals will perceive greater barriers for engaging in group activity than moderately or highly active individuals

Participants were categorised into low, moderate and high active groups based on their physical activity levels measured by the IPAQ (Methods Section 3.2.1 c). There were significant differences between barriers of group and solo physical activity in low, moderate and highly active participants (including a large, medium and medium effect size respectively, Table 3.22, Figure 3.1).

Table 3.22 Differences in Barriers to Group Versus Solo Physical Activity Between Physical Activity Levels

	Barriers to Group Physical Activity		Barriers to Solo Physical Activity		Difference between Group and Solo Physical Activity Barriers (two-tailed)	Effect size (Cohen's D)
	M	SD	M	SD		
Low (n=15)	2.98	1.09	2.20	0.75	t(14)= 2.82, p=0.01	0.88
Moderate (n=48)	2.74	1.04	1.95	0.95	t(47)= 4.40, p<0.01	0.79
High (n=58)	2.52	1.03	1.90	1.07	t(58)= 3.93, p<0.01	0.59

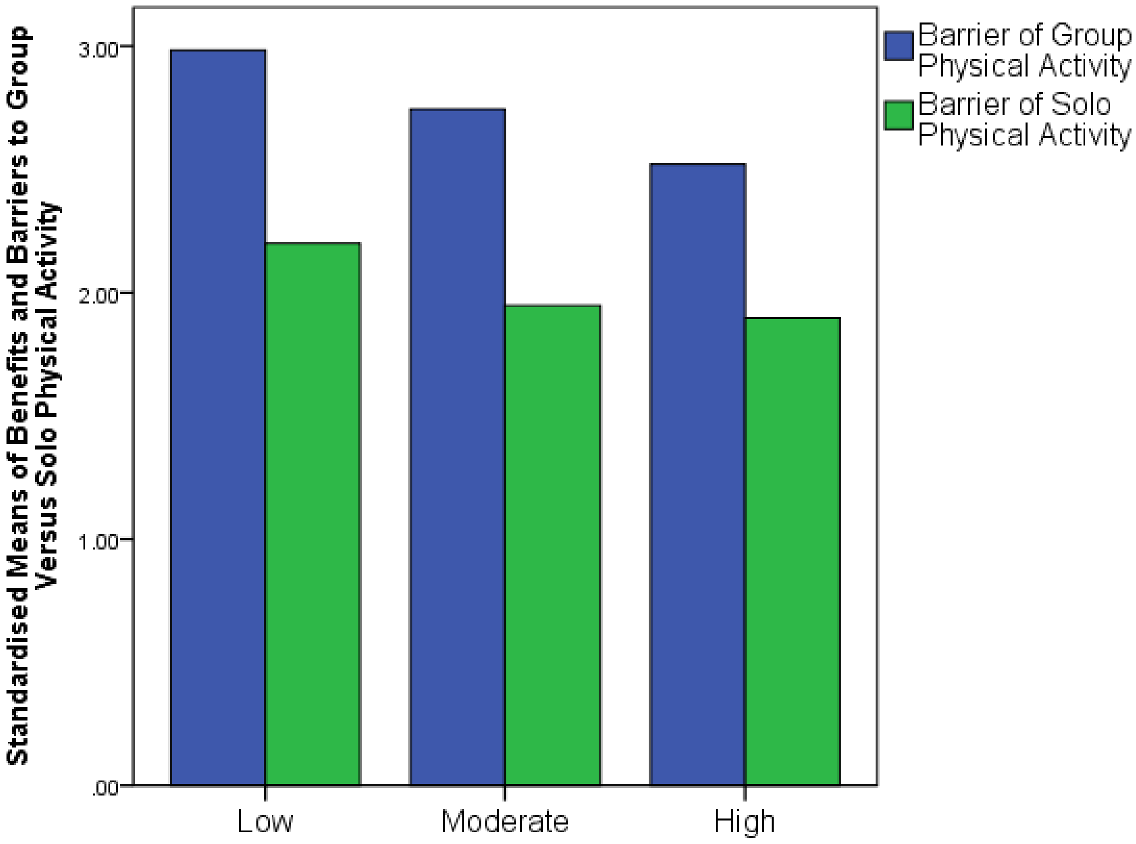

Figure 3.1 Barriers to Group Versus Solo Physical Activity Between Physical Activity Levels

Hypothesis 2b - Low active individuals will perceive lesser benefits for engaging in group activity than moderately or highly active individuals

There were no significant differences between benefits of group and solo physical activity in low, moderate and highly active participants (Table 3.23, Figure 3.2).

Table 3.23 Differences in Benefits to Group Versus Solo Physical Activity Between Physical Activity Levels

	Barriers to Group Physical Activity		Barriers to Solo Physical Activity		Difference Between Benefits of Group Versus Solo Physical Activity (two-tailed)
	M	SD	M	SD	
Low (n=15)	19.20	4.06	19.53	5.55	t(14)= 0.19, p=0.85
Moderate (n=48)	18.84	4.10	19.39	3.72	t(48)=0.65, p=0.52
High (n=58)	18.93	4.84	18.17	5.16	t(57)= 0.98, p=0.33

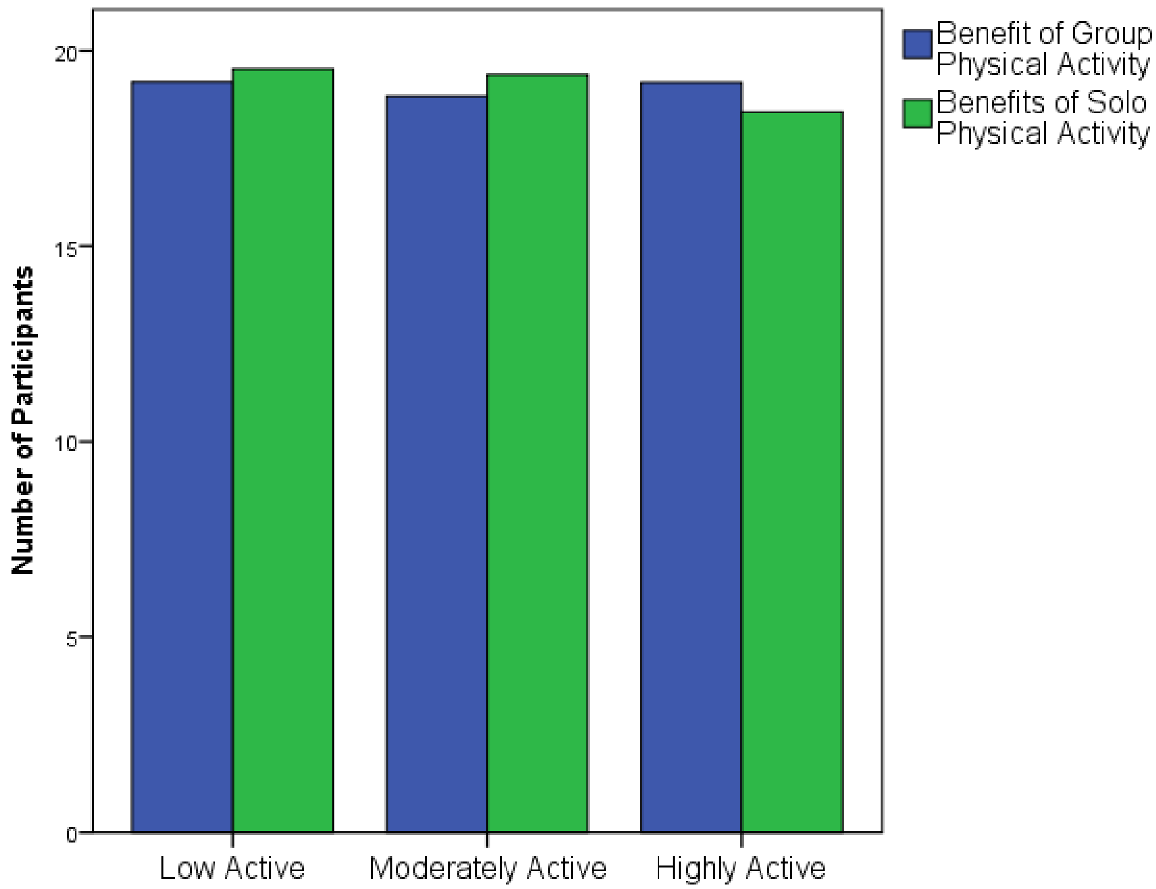

Figure 3.2 Benefits to Group Versus Solo Physical Activity Between Physical Activity Levels

Hypothesis 3 - Low active individuals will have a greater preference for solo physical activity than group physical activity than moderately or highly active individuals.

Preference was coded into one categorical variable, including group, solo and equal preference to engage in physical activity. Equal preference was defined by equal Likert scores for group and solo preference. Assumptions of Chi-Square concerning the minimum expected cell frequency was violated and not within recommended ranges (Cochrane, 1952, Conover, 1999, p.202) and was therefore not reported. However participants in all activity level categories indicated a greater preference for group physical activity (Table 3.24, Figure 3.3). A greater number of participants reported equal preference for group and solo physical activity when they were highly active than moderate and low.

Table 3.24 Preference for Group and Solo Physical Activity

Activity Level	Preference for Group Physical Activity		Preference for Solo Physical Activity		Equal Preference		Total
	N	%	N	%	n	%	n
Low	5	33.33	4	26.67	6	40.00	15
Moderate	28	56.00	15	30.00	7	14.00	50
High	30	49.18	16	26.23	15	24.59	61
Total	63	50.00	35	27.78	28	22.22	126

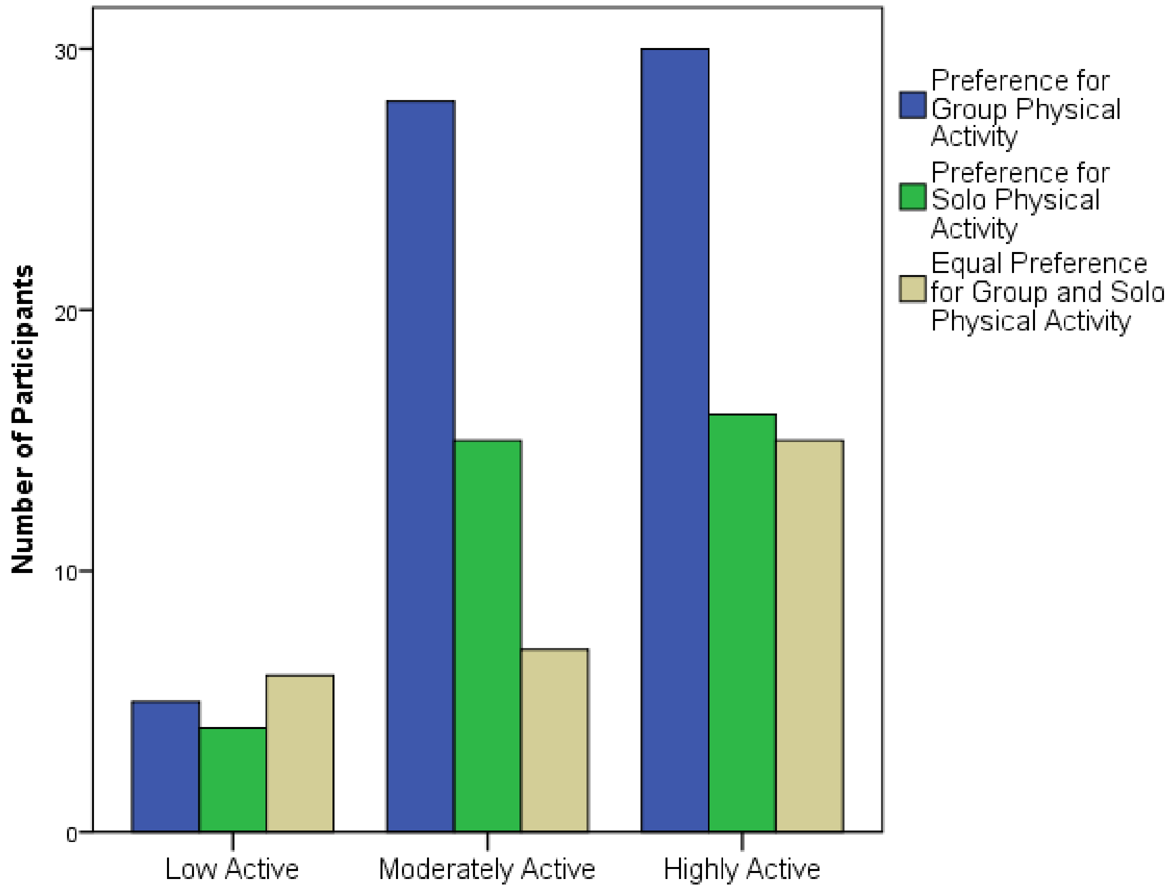

Figure 3.3 Preference for Group and Solo Physical Activity Between Physical Activity Levels

Hypothesis 4 - The following factors will be predictive of group and solo physical activity; the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety

The total number of independent variables which can be entered into the regression model is 7 (N=126), as per formula recommended by Green (1991; N > 50 + 8 x M).

Therefore, standard multiple regression was used to assess the predictive utility of the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety on group and solo physical activity. Assumptions of standard regression were investigated; collinearity statistics showed that there was no violation of multicollinearity assumptions. However, probability plot indicated non-normal distribution. Plot of standardised residuals were roughly distributed and did not demonstrate systematic pattern. Mahalanobis Distance was inspected for outliers, and three cases were identified (using a critical value of 24.32, Tabachnik & Fidell, 1996). However the cases were not excluded as responses to questionnaire items were valid. In addition, all Cook's Distance were less than 1.0, and were considered acceptable (Tabachnik & Fidell, 2001, p.69).

The total variance of group physical activity explained by the model as a whole was 12.9%, $F(7, 110) = 2.33$, $p=0.03$. The two variables that contributed uniquely significantly to group physical activity were barriers to group physical activity ($b = -1.96$, $p=0.05$, 3.03% unique contribution) and benefits to group physical activity ($b = 0.21$, p-0.02, part = 0.218). The remaining variables contributed non-significantly, barriers to solo physical activity ($b = -0.07$, $p=0.46$), stress ($b = 0.04$, $p=0.76$), anxiety ($b = -0.09$, $p=0.49$), depression ($b = -0.14$, $p=0.34$) and benefits to solo physical activity ($b = -0.04$, $p=0.68$)

The total variance of solo physical activity explained by the model as a whole was 2.8%, but the model was not significant $F(7, 110) = 0.45$, $p=0.87$. None of the variables contributed significantly including barriers to group physical activity ($b= 0.08$, $p=0.44$), barriers to solo physical activity ($b=-0.15$, $p=0.14$), benefits to group physical activity ($b= 0.05$, $p=0.57$), benefits to solo physical activity ($b= 0.04$, $p=0.68$), stress ($b=-0.02$, $p=0.91$), anxiety ($b=-0.03$, $p=0.85$) and depression ($b=-0.02$, $p=0.87$).

3.3.2 Student sample results

Five hundred and twenty two individuals responded to the online questionnaire. Ten were excluded from analysis as they indicated they were not university students, one was excluded as they indicated they were a school pupil, two were excluded as they chose not to respond to any of the items. Of the remaining 509 responses, 147 did not complete any measures beyond demographic information, 362 completed at least one measure. There were no significant differences between respondents who completed at least one measure and those who completed only demographic information of sex, relationship status, number of children or university enrolment status (Table 3.2525). There was also not a significant difference in age between those who completed at least one measure ($M=22.52$, $SD=4.80$, $n=357$) and those who completed only demographic information ($M=21.78$, $SD=4.70$, $n=140$), $t(495) = 1.56$, $p=0.1$.

Table 3.25 Differences In Sample Between Those Who Completed At Least One Measure and Those Who Completed Demographic Information Only

	Completed at Least One Measure		Completed Demographic Information Only		Differences (Chi-Square)
	n	%	n	%	
Sex					
Male	117	32.32	59	40.14	$\chi^2(2, n=509) = 4.48$, $p=0.11$
Female	242	66.85	85	57.82	
Decline to respond	3	0.83	3	2.04	
Total	362	100.00	147	100.00	
Relationship Status					
Single	163	45.03	82	55.78	$\chi^2(3, n=509) = 6.24$, $p=0.10$
In a relationship	149	41.16	51	34.69	
Married/Co-habiting	45	12.43	11	7.48	
Declined to respond	5	1.38	3	2.04	
Total	362	100.00	147	100.00	
Number of Children					
No Children	350	96.69	138	93.88	$\chi^2(3, n=509) = 5.01$, $p=0.17$
1 Child	8	2.21	8	5.44	
Declined to respond	4	1.10	1	0.68	
Total	362	100.00	147	100.00	
University Enrolment Status					
1st Year Undergraduate	81	22.38	39	26.53	$\chi^2(6, n=509) = 3.56$, $p=0.74$
2nd Year Undergraduate	81	22.38	33	22.45	
3rd Year Undergraduate	56	15.47	23	15.65	
4th Year Undergraduate	37	10.22	14	9.52	
Masters Degree	34	9.39	10	6.80	
Ph.D.	29	8.01	7	4.76	
Declined to Respond	44	12.15	21	14.29	
Total	362	100.00	147	100.00	

The sample was examined for weighting by postgraduate/undergraduate status and age category. Two hundred and ninety (80.11%) participants provided sufficient information in which to be weighted, 72 respondents (19.89%) did not provide either their age or their undergraduate or postgraduate status.

There was not a significant difference in age between the sample that provided sufficient information in which to be weighted (M=22.27, SD=4.45, n=290) and those who did not (M=23.61, SD=6.02, n=67), t(83.40) = -1.72, p=0.09 (equal variances not assumed). Likewise there were no significant differences in sex or relationship status between the sample that provided sufficient information in which to be weighted and those who did not (Table 3.26). However there appeared to be a greater proportion of individuals who declined to respond to the item relating to the number of children and the item relating to university enrolment status of those who did not provide sufficient information in which to be weighted than those who did (Table 3.26).

Table 3.26 Differences in Demographic Information Between Those who Provided Sufficient Information Versus Insufficient Information to be Weighted

	Sufficient Information Provided To Weight Sample		Insufficient Information Provided To Weight Sample		Differences
	n	%	n	%	
Sex					
Male	96	33.10	21	29.17	χ^2(2, n=362) = 4.14, p=0.11
Female	193	66.55	49	68.06	
Decline to respond	1	0.34	2	2.78	
Total	290	100.00	72	100.00	
Relationship Status					
Single	137	47.24	26	36.11	χ^2(3, n=362) = 4.39, p=0.22
In a relationship	117	40.34	32	44.44	
Married/Co-habiting	33	11.38	12	16.67	
Declined to respond	3	1.03	2	2.78	
Total	290	100.00	72	100.00	
Number of Children					
No Children	279	96.21	66	91.67	χ^2(3, n=360) = 12.35, p=0.01
1 Child	6	2.07	2	2.78	
2 Children	3	1.03	1	1.39	
Declined to respond	2	0.69	3	4.17	

	Sufficient Information Provided To Weight Sample		Insufficient Information Provided To Weight Sample		Differences
	n	%	n	%	
Total	290	100.00	72	100.00	
University Enrolment Status					
1st Year Undergraduate	67	23.10	14	19.44	$\chi^2(6, n=362) = 209.39, p<0.01$
2nd Year Undergraduate	73	25.17	8	11.11	
3rd Year Undergraduate	51	17.59	5	6.94	
4th Year Undergraduate	36	12.41	1	1.39	
Masters Degree	34	11.72	0	0.00	
Ph.D.	29	10.00	0	0.00	
Declined to Respond	0	0.00	44	61.11	
Total	290	100.00	72	100.00	

There was significantly more group physical activity reported by individuals who provided sufficient information required to weight the sample versus those who provided insufficient information (Table 3.27). In addition, depression, anxiety and psychological distress was significantly greater in individuals who provided insufficient information for weighting versus those who provided insufficient information. There were no significant differences between preference to engage in group physical activity, solo physical activity and equal preference, $\chi^2(2, n=297) = 2.13, p=0.35$ (Table 3.28).

Table 3.27 Differences in Measures Between Those who Provided Sufficient Information Versus Insufficient Information to be Weighted

	Sufficient Information Provided To Weight Sample			Insufficient Information Provided To Weight Sample			Differences (T-tests)
	N	M	SD	n	M	SD	
Physical Activity (MET-min/week)	223	3987.14	4062.12	60	2915.36	3047.26	t(281) = 1.90, p=0.06
Solo Physical Activity (MET-min/week)	226	1205.39	1648.20	67	850.53	1140.86	t(291) = 1.30, p=0.20
Group Physical Activity (MET-min/week)	242	966.53	1713.83	72	460.48	1098.42	t(145.94) = 2.41, p=0.02 (equal variances not assumed)
Depression	216	4.04	4.46	63	5.35	4.71	t(277) = -2.03, p=0.04
Anxiety	216	3.02	3.64	63	4.71	4.93	t(82.73) = -2.54, p=0.01 (equal variances not assumed)
Stress	215	5.23	4.55	63	6.35	5.12	t(276) = -1.67, p=0.10
Psychological Distress	212	12.11	11.18	63	16.41	13.13	t(90.38) = -2.36, p=0.02 (equal variances not assumed)
Barriers to Group Physical Activity	234	11.61	3.89	65	12.02	3.81	t(297) = -0.74, p=0.46
Barriers to Solo Physical Activity	229	3.89	1.94	64	3.59	1.91	t(291) = 1.09, p=0.28
Benefits of Group Physical Activity	234	20.40	3.37	64	18.84	4.31	t(85.26) = 2.68, p=0.01 (equal variances not assumed)
Benefits of Solo Physical Activity	229	20.26	3.50	63	20.52	3.10	t(290) = -0.54, p=0.59

Table 3.28 Mean and Percentage of Individuals Who Provided Sufficient and Insufficient Information To Be Weighted

	Insufficient Information Provided To Weight Sample		Sufficient Information Provided To Weight Sample	
	N	%	n	%
Preference for Group Physical Activity	19	29.69	91	39.06
Preference for Solo Physical Activity	29	45.31	86	36.91
Equal Preference	16	25.00	56	24.03
Total	64	100.00	233	100.00

Weighted Sample

The sample was weighted according to the proportions of undergraduate and postgraduates per age groups (including those under 20, aged 21 to 24, aged 25-29 and those aged 30 and over) using the 2013/2014 data from the Higher Education Statistics Agency Limited (HESA, 2015, Table 3.29). Weighting the sample resulted in a mean age of 22.42 (SD=4.20, n=371) and the following demographic information (Table 3.30) and summary of measures (Table 3.31).

Table 3.29 Proportions Used To Weight Sample

	Age	HESA Proportion	Current Study Proportions	Weighting
Undergraduate Students	20 and under	38.19	43.45	0.88
	21-24	19.51	7.59	2.57
	25-29	5.81	8.28	0.70
	30 and over	1.30	2.07	0.63
Postgraduate Students	20 and under	0.11	0.00	
	21-24	7.55	25.17	0.30
	25-29	5.76	8.97	0.64
	30 and over	10.03	4.48	2.24

Table 3.30 Weighted Demographic Information

	n	%
Sex		
Male	114	30.68
Female	257	69.08
Decline to respond	1	0.24
Total	371	100.00
Relationship Status		
Single	183	49.17
In a relationship	147	39.52
Married/Co-habiting	36	9.78
Declined to respond	6	1.53
Total	371	100.00
Number of Children		
No Children	361	97.24
1 Child	6	1.50
2 Children	3	0.85
Declined to respond	2	0.41
Total	371	100.00
University Enrolment Status		
1st Year Undergraduate	69	18.60
2nd Year Undergraduate	85	22.76
3rd Year Undergraduate	88	23.62
4th Year Undergraduate	73	19.55
Masters Degree	30	8.02
Ph.D.	28	7.46
Total	371	100.00

Table 3.31 Weighted Means and Standard Deviations of Measures

	n	M	SD
Physical Activity (MET-min/week)	295	3916.03	4211.48
Solo Physical Activity (MET-min/week)	288	1181.96	1521.52
Group Physical Activity (MET-min/week)	317	907.76	1533.45
Depression	277	4.34	4.66
Anxiety	275	3.10	3.63
Stress	276	5.64	4.62
Psychological Distress	272	12.89	11.25
Barriers to Group Physical Activity	297	11.88	3.94
Barriers to Solo Physical Activity	289	3.95	1.84
Benefits of Group Physical Activity	297	20.37	3.50
Benefits of Solo Physical Activity	289	20.47	3.39

Table 3.32 Weighted Preference for Group and Solo Physical Activity and Equal Preference

	N	%
Preference for Group Physical Activity	113	30.4
Preference for Solo Physical Activity	124	33.3
Equal Preference	59	16.0
Total	296	79.7

Hypothesis 1a - Greater Levels of Physical Activity Will Be Related to Lower Levels of Psychological Distress

Hypothesis 1b – Group Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

Hypothesis 1c – Solo Physical Activity Will Be Associated With Lower Levels of Psychological Distress than Solo Activity

There was not a significant correlation between physical activity and depression, anxiety, stress or psychological distress overall (Table 3.33, Table 3.34). There was a significant positive small correlation between solo physical activity and anxiety, but no further correlations between solo physical activity and any of the other subscales of psychological distress. There were significant negative small correlations between group physical activity and depression, stress, psychological distress overall, but not a significant correlation with anxiety (Table 3.34).

Table 3.33 Weighted Mean and Standard Deviations of Physical Activity and Psychological Distress

	n	M	SD
Physical Activity (MET-min/week)	295	3916.03	4211.48
Solo Physical Activity (MET-min/week)	288	1181.96	1521.52
Group Physical Activity (MET-min/week)	317	907.76	1533.45
Depression	277	4.34	4.66
Anxiety	275	3.10	3.63
Stress	276	5.64	4.62
Psychological Distress Overall	272	4.34	4.66

Table 3.34 Correlations of Weighted Physical Activity, Group and Solo Physical Activity and Psychological Distress

	Physical Activity	Solo Physical Activity	Group Physical Activity
Depression	r=-0.10, p=0.09, n=208	r= -0.04, p=0.26, n=265	r= -0.24, p<0.01, n=272
Anxiety	r=0.10, p=0.07, n=205	r= 0.11, p=0.03, n=263	r= -0.02, p=0.09, n=270
Stress	r=0.00, p=0.49, n=208	r< 0.01, p=0.48, n=264	r= -0.21, p<0.01, n=271
Psychological Distress Overall	r=-0.01, p=0.44, n=204	r= 0.04, p=0.28, n=260	r= -0.20, p<0.01, n=267

Hypothesis 2a – Low active individuals will perceive greater barriers for engaging in group activity than solo, than moderately or highly active individuals

Barriers to group and solo physical activity scales did not contain the same number of items, and were therefore both standardised for comparison by adding the items and then dividing by the total number of items per scale. Participants of all activity levels perceived significantly greater barriers to group physical activity than solo and demonstrated large effect sizes (Table 3.35, Figure 3.4).

Table 3.35 Means, Standard Deviations and Paired T-Tests of Barriers of Group and Solo Physical Activity between Low, Moderate and Highly Active Participants

Activity Level	Barriers of Group Physical Activity		Barriers of Solo Physical Activity		Differences Between Physical Activity Levels (Two-Tailed)	Effect Size (Cohen's D)
	M	SD	M	SD		
Low (n=17)	3.20	0.50	2.22	1.04	t(16)= 4.88. p<0.01	1.20
Moderate (n=134)	3.13	1.01	2.08	0.94	t(133) = 10.68. p<0.01	1.01
High (n=102)	2.74	1.00	1.80	0.83	t(101) = 9.09. p<0.01	1.02

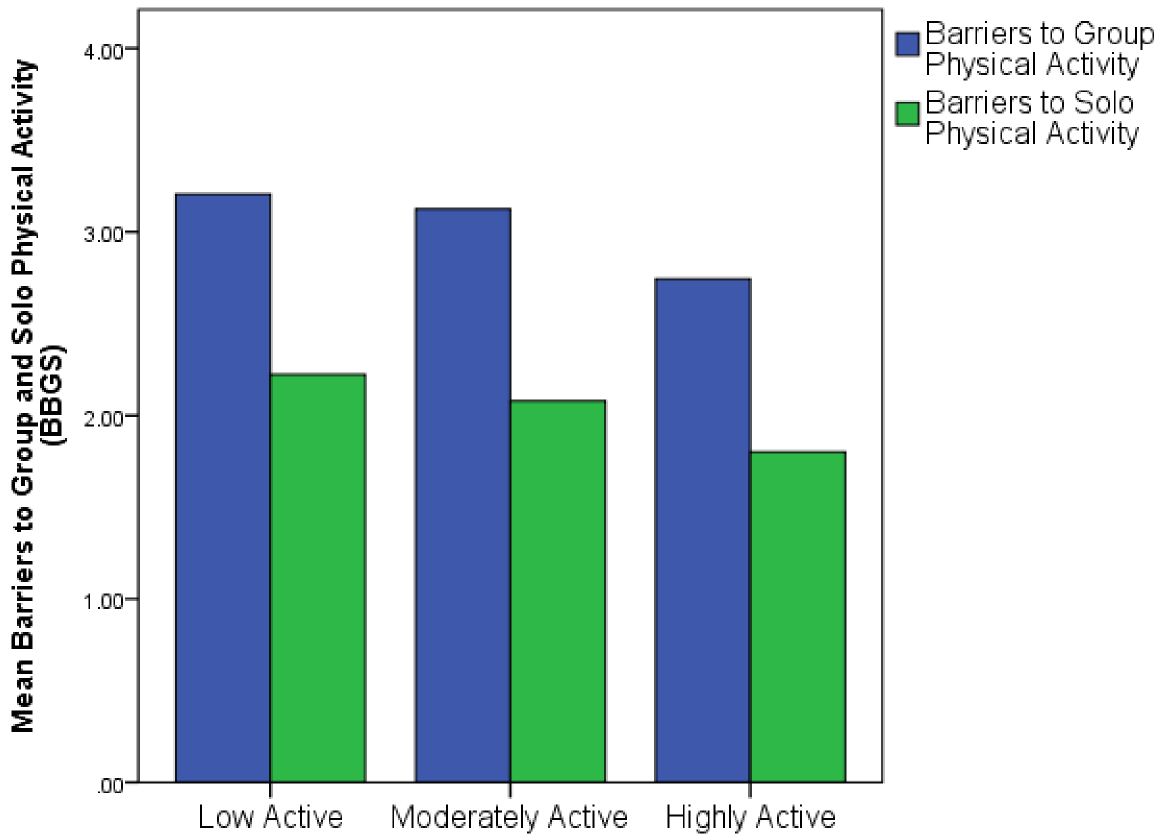

Figure 3.4 Barriers of Group and Solo Physical Activity in Low, Moderate and Highly Active Participants

Hypothesis 2b - Low active individuals will perceive lesser benefits for engaging in group activity than solo, than moderately or highly active individuals

Participants were categorised into low, moderate and high active groups based on their physical activity levels measured by the IPAQ. There were no significant differences between the benefits of group and solo physical activity in low or moderately active participants, however highly active participants significantly perceived greater benefits to group than solo, the effect size was small (Cohen's d=0.31,Table 2.1, Figure 3.5).

Table 3.36 Means, Standard Deviations and Paired T-Tests of Benefits of Group and Solo Physical Activity between Low, Moderate and Highly Active Participants

Activity Level	Benefits of Group Physical Activity		Benefits of Solo Physical Activity		Differences Between Physical Activity Levels (Two-Tailed)
	M	SD	M	SD	
Low (n=17)	19.59	3.74	21.39	3.92	t(16)=-1.26, p=0.23
Moderate (n=134)	19.86	4.06	20.55	3.47	t(113)= -1.29, p=0.20
High (n=102)	21.24	2.60	20.35	3.13	t(101)= 2.16, p=0.03

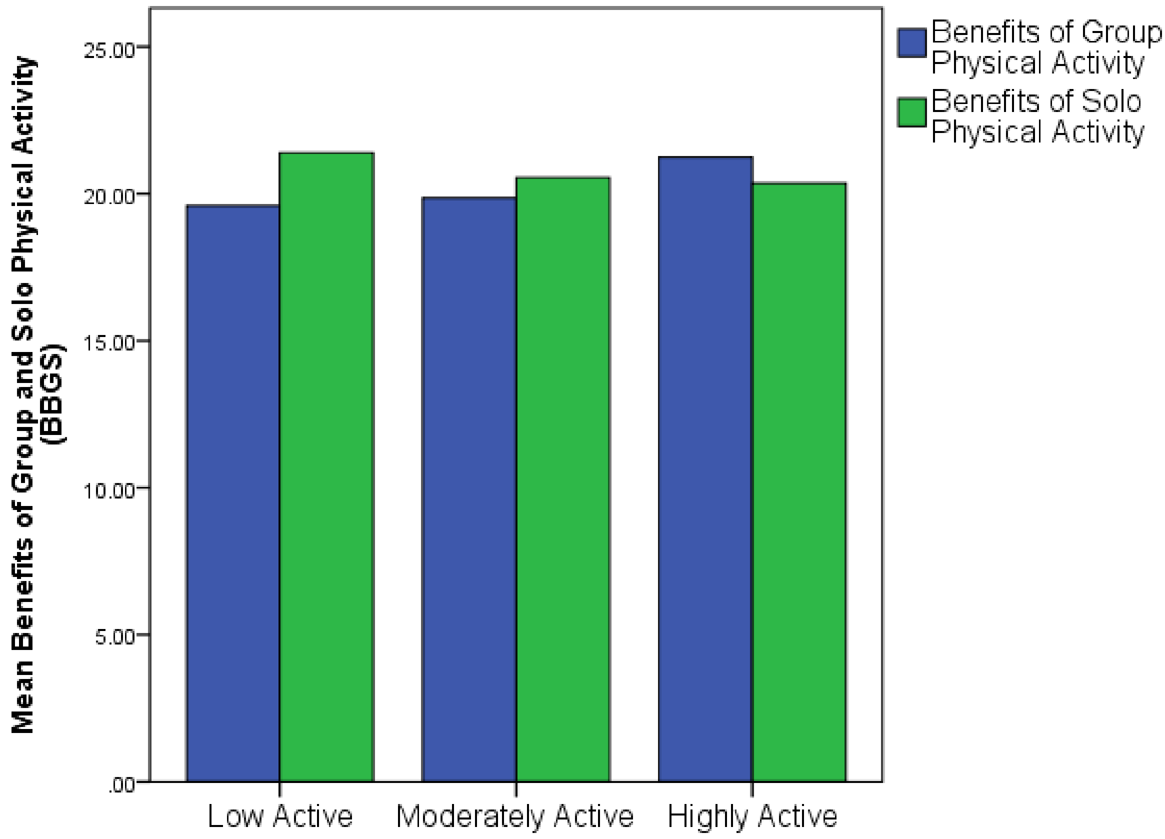

Figure 3.5 Benefits of Group and Solo Physical Activity in Low, Moderate and Highly Active Participants

Hypothesis 3 - Low active individuals will have a greater preference for solo physical activity than group physical activity than moderately or highly active individuals.

Preference was coded into one categorical variable, including group, solo and equal preference to engage in physical activity. Equal preference was defined by equal

Likert scores for group and solo preference. There were no significant differences in activity level and preference for group and solo physical activity, X^2, (4) = 8.03, p=0.09, n=258 (Table 3.37, Figure 3.6). However more low active participants indicated a greater preference for solo physical activity than group or an equal preference while slightly more high active participants indicated a preference for group over solo and an equal preference.

Table 3.37 Low, Moderate and Highly Active Participant Preferences For Group And Solo Physical Activity

	Group Preference		Solo Preference		Equal Preference		Total
Activity Level	n	%	n	%	N	%	n
Low Active	3	15.79	12	63.16	4	21.05	19
Moderately Active	54	40.60	57	42.86	22	16.54	133
Highly Active	41	38.68	38	35.85	27	25.47	106
Total	98	37.98	107	41.47	53	20.54	258

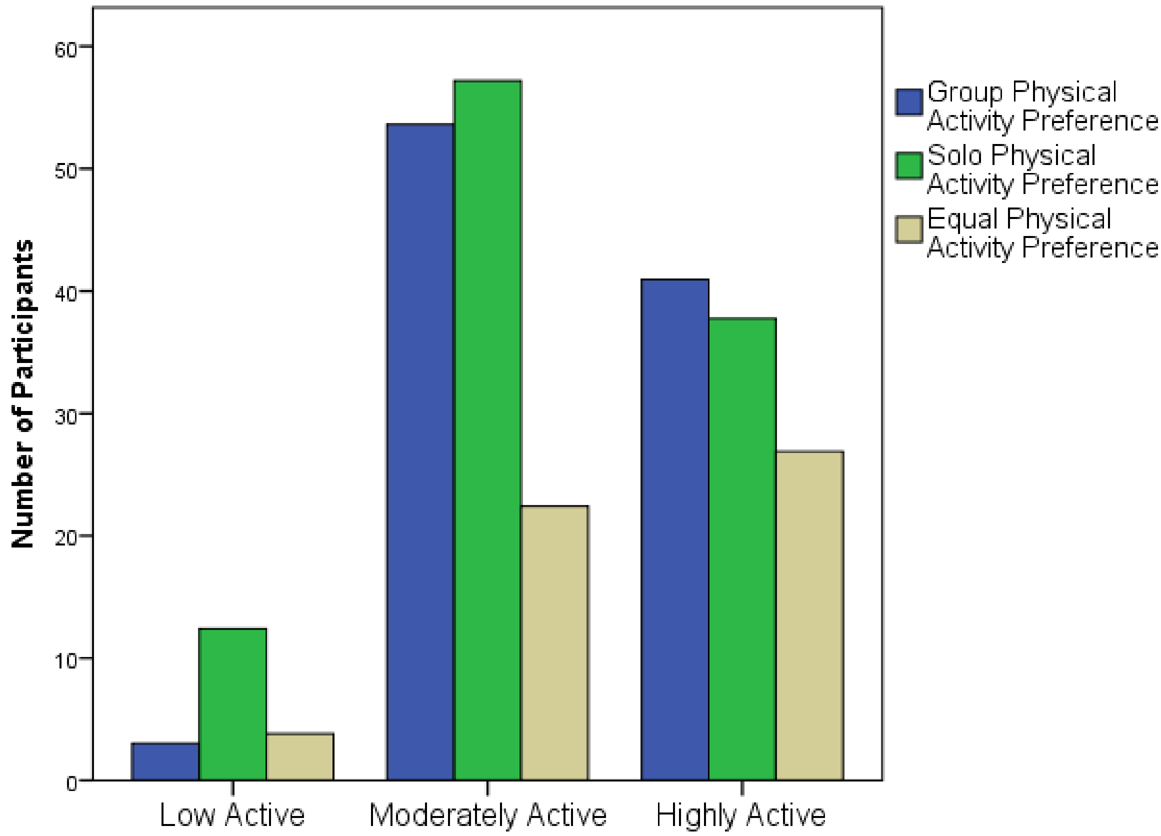

Figure 3.6 Preference for Group and Solo Physical Activity Between Physical Activity Levels

Hypothesis 4 - The following factors will be predictive of group and solo physical activity; the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety

Standard multiple regression was used to assess the predictive utility of the subscales of benefits and barriers of group versus solo physical activity, stress, depression and anxiety on group ad solo physical activity. Assumptions of standard regression were investigated; collinearity statistics showed that there was no violation of multicollinearity assumptions. However, probability plot indicated non-normal distribution. Plot of standardised residuals were roughly distributed and did not demonstrate systematic pattern. Mahalanobis Distance was inspected for outliers, and four cases were identified (using a critical value of 24.32, Tabachnik & Fidell, 1996). However the cases were not excluded as responses to questionnaire items were valid. In addition, all Cook's Distance were less than 1.0, and were considered acceptable (Tabachnik & Fidell, 2001, p.69).

The total variance of group physical activity explained by the model as a whole was 21.4%, $F(7, 262) = 10.19$, $p<0.01$, barriers to group physical activity (b-=0.38, $p<0.01$, 10.11%) made the only unique significant contribution, the remaining variables did not contribute significantly including barriers of solo physical activity (b=0.10, p=0.10), benefits of group physical activity (b=0.05, p=0.40), benefits of solo physical activity (b=-0.08, p=0.18), depression (b=-0.15, p=0.08), anxiety (b=0.09, p=0.22) and stress (b=-0.05, p=0.56).

The total variance of solo physical activity explained by the model as a whole was 6.3%, 6.3%, $F(7, 255) = 2.47$, p=0.02. Anxiety was the only variable to contribute significantly to solo physical activity (b=0.20, p=0.02, including 2.16% of unique variance), all other variables did not contribute significantly including depression (b=-0.08, p=0.38), stress (b=-0.05, p=0.61), barriers of group physical activity (b=-0.07, p=0.32), barriers of solo physical activity (b=-0.02, p=0.74), benefits of group physical activity (b=0.13, p=0.06) and benefits of solo physical activity (b=0.12, p=0.06).

3.4 **Discussion**

This study investigated the relationship between psychological distress (including stress, depression and anxiety) and group and solo physical activity; the benefits and barriers to group versus solo physical activity; and preference to group and solo physical activity in separate student and community samples.

3.4.1 The Relationship between Psychological Distress and Group and Solo Physical Activity

The first hypothesis predicted that general physical activity as measured by the IPAQ would be associated with reduced psychological distress. However both samples found no correlation between physical activity and psychological distress. This does not support previous reviews that report correlations between physical activity and depression, anxiety and stress (Teychenne, Ball & Salmon, 2008; Conn 2010a; Wipfli, Rethorst & Landers, 2009; Long & van Stavel, 1995; Conn, 2010b).

The first hypothesis also predicted that group and solo physical activity would be associated with reduced psychological distress. Both samples found small significant negative correlations between increased group physical activity and reduced depression and stress; and only anxiety in the community study.

There were no correlations between solo physical activity and psychological distress in either of the samples, apart from anxiety in the student sample, where increased anxiety was associated with increased solo physical activity. These findings lend some support to Burke et al.'s (2006) systematic review that found group exercise classes superior to home-based activity without contact (but not significantly). These correlational findings cannot imply causation, while group physical activity may reduce psychological distress it is possible that less distressed individuals may have greater capacity to initiate and engage in group physical activities than solo.

The findings may lend support to socially facilitated mechanisms of physical activity to reduce depression. For example, the social interaction hypothesis suggests that psychological well-being and mental health is improved by social relationships, interaction and support from others in a physical activity setting (Randford, 1982). Baumeister and Leary (1995) suggest that the need to belong and the desire to form interpersonal attachments is a fundamental human motivation. This may be satisfied by being physically active in a structured exercise class (Carron, Burke & Prapavessis, 2004). Baumeister and Leary (1995) argue social bonds are formed easily and social approval is a strong form of social reinforcement and can elevate mood states (Ross & Hayes, 1988).

Social support can be conceptualised as perceptions of “group cohesion” (Duncan et al., 1993; Courneya & McAuley, 1995; Kwak et al., 2005). Festinger (1950) described cohesion as the forces which influence members to remain in a group. A meta-analysis by Carron, Hausenblas, and Mack (1996) found that increased group cohesion was related to increased adherence. They reported that engaging in physical activity with others has a small to moderate effect on adherence behaviour and that the effect increased to moderate to large when individuals participated in cohesive groups. In addition, Nolen-Hoeksema (1991) suggests social support may mediate the relationship between rumination and depression (provided the social support encourages the individual to stop ruminating and start engaging in distracting activities).

The positive correlation of increased anxiety with increased solo physical activity and lack of correlation of anxiety with group physical activity in the student sample, may suggest that if an anxious individual is motivated to engage in physical activity they may seek out solitary activities. The regression analysis relating to hypothesis four found that anxiety predicted engagement in solo physical activity in the student sample only. It is possible that these students self-regulate their anxiety with solo physical activity.

The regulation of anxiety using solo physical activity may be facilitated through problem and emotional focused coping (Carver & Scheier 2001, p.214). For example, solo physical activity may be used as problem focused coping to maintain a weight or shape if the anxiety is related to body image. Alternatively solo physical activity may be used as emotional focused coping to regulate one's emotions. The mechanisms in which physical activity may reduce anxiety are not well understood

(Arent, Landers & Etnier, 2000; Daley, 2008; Deslandes et al., 2009) however physical activity may promote a sedating and anxiolysis effect through facilitation of the endocannabinoid system (Sparling, et al., 2003; Dietrich & McDaniel, 2004); regulation of the hypothalamic-pituitary-adrenocortical (HPA) axis (Faravelli, et al., 2012); and through regulation of cortisol, adrenocorticotropic hormone, and corticosteroids (Nabkasorn, et al., 2005). If group participation triggers anxiety then the physical activity related physiological anxiolytic effects may feel counteracted. Therefore to increase physical activity levels in anxious individuals it may be more appropriate to promote solo physical activity, however further investigation is required to confirm this, especially in a non-student population.

3.4.2 Benefits and barriers to group versus solo physical activity

The second hypothesis first predicted that low active individuals would perceive greater barriers for engaging in group physical activity than solo, than moderately or highly active individuals. In both student and community sample participants of all activity levels perceived significantly greater barriers to group physical activity than solo. Effect sizes were greater for low active individuals in comparison with moderate and high. This suggests that low active individuals do perceive greater barriers to group physical activity over solo than moderate or highly active individuals and supports the general findings from Freene, et al. (2014), who found that participants expressed more barriers to engaging in group physical activity than home-based.

The second hypothesis subsequently predicted that low active individuals would perceive lesser benefits for engaging in group activity than solo, than moderately or highly active individuals. However within the community sample there were no significant differences between benefits of group and solo physical activity in low, moderate and highly active participants. Likewise, within the student sample there were no significant differences found in low or moderately active participants, however highly active participants significantly perceived greater benefits to group than solo. Highly active students may not be able to schedule all of their physical activity needs around others, and thus may prefer solo physical activity due to increased flexibility compared with group.

3.4.3 Preference

The third hypothesis predicted that due to the hypothesised reduced perception in barriers, low active participants would prefer solo physical activity than group physical activity than moderately or highly active individuals.

However for the community sample the assumptions of Chi-Square were violated and therefore differences in significance could not be examined. Preference for solo physical activity was broadly similar between proportions of individuals engaging in low, moderate and high levels of physical activity, but preference for group physical activity was greater for proportions of moderate and highly active individuals over low. Preference for group and solo physical activity was perceived as broadly similar in low active participants.

In the student sample there was not a significant difference between low, moderate or highly active participants and preferences between group and solo physical activity. Similar proportions of moderate and highly active participants appeared to have similar preferences for group and solo physical activity. There was a greater proportion of low active students who preferred solo physical activity over group.

These findings did not support Burke, Carron and Eys (2006) who found that university students preferred group physical activity to solo. However this may relate to the limited question as Burke's measure was more detailed offering four options, unstructured group activity, structured classes, physical activity alone in an exercise setting and completely alone. Further investigation into this area would benefit from a more detailed questionnaire. In addition, both samples included a low number of low active individuals, further sampling is required.

3.4.4 Implications

These findings suggest that group physical activity is associated with reduced psychological distress, however group physical activity is perceived as having more barriers to engagement than solo. While it was difficult to discern a clear pattern of group versus solo physical activity preference, if a low active individual has a preference for group physical activity they may encounter sufficient barriers to prevent engagement in group physical activity and attempt solo physical activity instead. They may not achieve the full psychological benefit gained from engaging in a group or alternative benefits such as increased adherence (Carron et al. 1996), which may result in attrition on non-concordance with the solo physical activity.

3.4.5 Strengths and limitations

One of the benefits of these studies was that both samples provided evidence for the relationship with psychological distress and group physical activity in a general population, which extends beyond the findings identified within the systematic review and Burke et al.'s (2006) meta-analysis where the majority of included papers were based on clinical samples.

One of the limitations in both samples was the poor response rate of low active individuals, who perhaps were less willing to complete a questionnaire pack relating to health and physical activity. They may have felt their low physical activity behaviour would be perceived negatively as physical activity is promoted as a healthy activity (Health Promotion Service, NHS Lothian, 2014). Further investigation is required to confirm findings with low active individuals, sampling may benefit from identifying sources of low active individuals, potentially from primary care facilities, or a more intensive sampling process involving a greater number of individuals overall which would provide a greater sample of low active individuals.

The sample was weighted by enrolment status and age, proportions of females to males in the current study was somewhat greater than that found by the HESA (65/34/1% F/M/No response, versus 56%/44% F/M). Lowell (1998) reports that more women than men complete online questionnaires, which may explain the higher female response rate. Consequently the findings from the student sample may be less generalisable to men than women. In addition the sample may have been slightly skewed due to a number of student participants not providing sufficient information to be weighted. These students reported significantly greater psychological distress and less physical activity than students who did provide sufficient information.

As previously mentioned the questionnaire on preference was limited, and may have provided a diverse range of answers if it had been similar to that of Burke, Carron and Eys (2006) who measured four conditions including unstructured and structured group activity and physical activity alone in an exercise setting and completely alone.

3.4.6 Future investigation

Further investigation would benefit from a more detailed measure of group versus solo physical activity preference such as devised by Burke et al. (2006b) which may include different locations (such as exercising alone at home versus exercising alone in a gym or health facility). Further investigation may benefit from exploring the effect of solo physical activity on anxiety. It is possible that student participants were responding to physical or emotional cues related to anxiety and may have been regulating their mood through solo physical activity. Further research may benefit from examining the potential moderating effect of emotional intelligence on physical activity. Emotional intelligence can be defined as “the ability to carry out accurate reasoning about emotions and the ability to use emotions and emotional knowledge to enhance thought” (Mayer et al., 2008, p. 111) and through meta-analysis greater emotional intelligence was associated with better mental and physical health (Schutte et al., 2007).

The regression analyses found that group and solo physical activity benefits significantly predicted group physical activity in the community sample, but only barriers to group significantly contributed to group physical activity in the student sample. This suggests that promotion of group physical activity to the community should involve both group and solo physical activity benefits. However, for a student population it may be more important to focus on overcoming barriers. An intervention based on this may seek to identify barriers (such as those included in the measure relating to finding a group, competitiveness, self-presentation and similar degree of standards of engaging in activities) and rehearsing what would be necessary to successfully change a behaviour rather than the reasons why an individual cannot perform the behaviour (Ashford et al., 2000). This may be more easily facilitated in a student population than in the community due to the wide range of sporting clubs, associations and facilities provided by the university.

3.5 **Conclusion**

This study found low active individuals from both samples perceived greater barriers to group physical activity than solo and may prefer solo physical activities over group but further evidence is required to confirm these preferences. In addition further evidence is required to understand the different factors associated with participation in group versus solo physical activity, which will be examined in Chapter 5.

This study provided evidence that group physical activity is associated with lower levels of psychological distress (including depression and anxiety) in a student and community sample. A high quality intervention based study would be useful to confirm the effect of group versus solo physical activity on reduced psychological distress, including depression, anxiety and stress, as the majority of group versus solo physical activity interventions focus on depression or mental health. To further investigate this relationship, an quasi randomised intervention study follows (Chapter 4) including a student population (similar to the one included in this study) to compare the change of psychological distress over a 10 week intervention period.

Chapter 4

Group Versus Solo Jogging and Psychological Distress in a Student Population

4.1 Introduction

Attending university can increase the risk of psychological distress (Bewick, Gill, Mulhern, Barkham & Hill, 2008; Burris, Brechting, Salsman, Carlson 2009) and university students have been found to demonstrate greater psychological distress than the general population (Roberts & Zelenyanski, 2002). Within the UK, a study including 2282 university students from a variety of degree subjects reported clinical levels of psychological distress in one in three students (Bewick et al., 2008). Ibrahim, Kelly, Adams, and Glazebrook (2013) argue that it important to reduce psychological distress in this population as it can limit career prospects and social relationships which may impact later life.

Previous reviews indicate that participation in physical activity may reduce depression (e.g. Teychenne, Ball & Salmon, 2008), anxiety (e.g. Conn, 2010) and stress (e.g. Long and van Stavel, 1995). Recent intervention studies support these findings in university student populations, which demonstrate that engagement in physical activity can reduce depression (Akandere & Demir, 2011; Soung-Hee, Myung-Soo & Kyum-Joo, 2013; Gondoh, Sensui, Kinomura, Fukuda, Fujimoto, Masud, Nagamatsu, Tamaki & Takekura, 2009; Atousa, 2009), anxiety (Asci, 2003; Baghurst & Kelley, 2014), social anxiety (Adilogullari, 2014) and stress (Baghurst & Kelley, 2014; von Haaren, Haertel, Stumpp, Hey & Ebner-Priemer, 2015). Nearly all of these interventions provided physical activity in a group-based context. Atousa (2009) conducted the only study involving university students to compare group and solo physical activity conditions and reported that group physical activity was significantly superior to solo in the reduction of depression. However the details were limited as it was a conference presentation and no further publications have been made elaborating on the data. Therefore further investigation is required to corroborate these findings.

Despite the psychological benefits of physical activity, students may not be engaging in sufficient physical activity levels to order to achieve them. The national survey of students reported that only 23% of students were reaching recommended levels of physical activity to improve psychological distress (30 minutes accumulated exercise on 5 or more days a week), 48% of students engaged in three 30 minute sessions of moderate intensity activity per week, and the remaining 29% engaged in less per week (National Active Student Survey, British Universities and College Sport and Leisure-net Solutions, 2007).

Adherence to physical activity is important to achieve the therapeutic effects (Allen & Moray,2003), and may be promoted by engaging in group physical activity versus solo. Burke, Carron, Eys, Ntoumanis and Estabrooks' (2006) meta-analysis indicated that physical activity adherence was significantly superior in true groups (incorporating team building exercises) over standard group exercise classes, and in standard group exercise classes over home-based physical activity without contact. However adherence was similar between standard group exercise classes and home-based physical activity with contact, but authors suggest this may have been related to similar levels of support received by participants. These findings may be confounded by different barriers of group versus home-based conditions, as those in the home-based conditions were not required to leave the home and may have been easier to complete. Attrition may also have biased the comparison of conditions as ITT (intention-to-treat) was inconsistently applied in the studies included in Burke et al.'s (2006a) meta-analysis. For example, Blumenthal et al. (2007) found attrition was greater for group physical activity than for solo and suggest this is due to context and classification. Participants were categorised as non-completers when they discontinued exercise for the remaining duration of their study. It was easier for participants assigned to solo physical activity to remain in the study by maintaining minimal involvement in the exercise programme. Attendance rates were slightly greater for home-based (93.9%) than supervised (82.9%) conditions. However when drop outs were excluded from analysis, completion rates were similar between home

(68%) and supervised exercisers (67%) who completed at least 75% of the 48 scheduled sessions. Likewise, the systematic review (Chapter 2) found similar levels of attrition between group and solo physical activity conditions, with slightly greater attrition from solo physical activity conditions (M=16.14%, SD=10.23%) than group (M=15.78%, SD=13.33%). This may be influenced by preference, for example, random assignment to a group or solo physical activity condition may lead to attrition as an individual may not favour their assigned physical activity condition. However as university students may prefer group physical activity to solo (Burke, Carron & Eys, 2006), adherence may be better in group based interventions than solo. Burke et al. (2006b) found female students preferred unstructured group activity followed by structured classes, physical activity alone in an exercise setting and completely alone. The male students preferred unstructured group physical activity, followed by engaging in physical activity alone but in an exercise setting, completely alone and finally a structured class. They were also asked to indicate in one or two sentences the reasoning for their preferences on the four physical activity contexts (Shapcott, Burke, Carron & Eys, 2007). Males and females reported unstructured group physical activity provided them opportunities for personal control, increased motivation and the presence of friends. The most frequently cited barriers female students encountered when exercising alone was difficulties staying motivated, adhering and boredom. Male students' least preferred activity was structured exercise settings and reported this was due to a lack of personal control and the possibility of comparison. However the students were sampled from a kinesiology undergraduate course where sport and exercise-related activities were compulsory and does not represent an inactive population.

Participation in exercise is often limited to that specified by the intervention in order to test the effect of the exercise prescription on the dependent variable without the confound of outside physical activity, therefore evidence examining the amount of physical activity achieved outside of the intervention is limited. However there is some evidence to suggest that overall physical activity levels outside of the intervention can be improved by both group and solo physical activity interventions. Casla, Hojman, Cubedo, Calvo, Sampedro & Barakat (2014) found a 12-week group physical activity intervention for breast cancer patients significantly increased leisure-time physical activity during the intervention period and was maintained after a 12-week follow-up. Likewise, Hunter, Wetzstein, Fields, Brown & Bamman (2000) found a solo supervised 26-week exercise intervention significantly increased older adults' physical activity levels outside of the intervention.

King, Caudwell, Hopkins, Byrne, Colley, Hills, Stubbs and Blundell (2007) suggests that exercise interventions may increase overall physical activity levels due to an increased subjective feeling of energy which motivates the individual to be more active outside the intervention or by replacing inactive with active behaviours. Alternatively this may be related to improvements in self-efficacy as self-efficacy acts as a determinant and a consequence of physical activity, both of which interact with each other (MaCauley & Blissmer, 2000). Therefore, engagement in physical activity may lead to an increase in self-efficacy which leads to further participation in physical activities. This may be more pronounced in group physical activity as Ashford, Edmonds and French (2010) found the most successful techniques to improve exercise self-efficacy include vicarious experiences (seeing others engage in the behaviour raises the individuals belief that they can also master that activity, Bandura, 1977) and the comparison of the individual’s performance with the performance of others (Ashford et al., 2010).

Only one study has compared the group and solo physical activity conditions and the change in overall physical activity levels during the intervention. Helbostad, Sletvold and Moe-Nilssen (2004) assigned participants to a group plus home/solo condition, and a home/solo only physical activity condition. Surprisingly participants significantly decreased their weekly walks in both conditions and there was no significant difference in the decrease between conditions. The differing findings to Casla et al. (2014) and Hunter et al. (2000) may be due to the older age and poorer mobility of participants in Helbostad et al.'s (2004) study. However it is also possible that individuals may engage in a compensatory decrease in physical activity when engaging in exercise interventions which may be related to frequently cited barriers such as a lack of time or feeling tired (Trost, Owen, Bauman, Sallis & Brown 2002). Students may have fewer time barriers as they have flexible schedules and greater opportunities through a variety of sports clubs and activity centres. No study has compared a group versus solo physical activity intervention and the impact on physical activity outside of the intervention in a student population.

The aim of the current study was to compare the psychological distress, adherence to the prescribed intervention and overall physical activity levels for participants assigned to group versus solo physical activity conditions. Jogging was chosen as the physical activity as it is directly comparable as a group and solo physical activity, is accessible to those with differing fitness levels, doesn't require specialised skills, is inexpensive and benefits participants as an activity they can continue to engage in after the intervention. In addition, this form of physical activity was chosen to overcome the criticisms identified from the studies included in the systematic review (Chapter 2) as many of the physical activity prescriptions differed between group and solo physical activity, and could not provide an adequate comparison of a group versus solo context.

Participation in exercise is often limited to that specified by the intervention to test the exercise prescription without the confound of outside physical activity. However two studies both provide evidence that group and supervised solo physical activity may lead to an increase on overall physical activity levels excluding physical activity from the intervention (Casla et al., 2014; Hunter, 2004); though no evidence could be found relating solo physical activity (without direct supervision) and the impact on physical activity levels outside of the intervention. As participation in exercise interventions may increase subjective feelings of energy and self-efficacy (which may be more pronounced in group environments, Ashford et al., 2010) that may promote further engagement in physical activity, the first hypothesis predicted that those assigned to the group jogging condition would engage in more physical activity overall than those assigned to the solo jogging condition.

Burke, et al.'s (2006) meta-analysis indicated that physical activity adherence was significantly superior in true groups over standard group exercise classes, and in standard group exercise classes over home-based physical activity without contact. However adherence was similar between standard group exercise classes and home-based physical activity with contact. The current study compares group and solo physical activity conditions, the benefit of this is that the solo physical activity condition unlike Burke et al.'s (2006) home condition requires participants to leave the home which is a more comparable condition to group physical activity than home-based, potentially incurring similar barriers. The second hypothesis predicted that those assigned to the group jogging condition would engage in more jogging activity than those assigned to the solo jogging condition.

The majority of previous studies in university student populations find that group physical activity can reduce depression (Akandere & Demir, 2011; Soung-Hee et al., 2013; Gondoh et al., 2009, Atousa, 2009), anxiety (Asci, 2003; Baghurst & Kelley, 2014), social anxiety (Adilogullari, 2014) and stress (Baghurst & Kelley, 2014; von Haaren et al., 2015). Only one study investigating university students comparing group and solo physical activity conditions found group physical activity was significantly superior to solo in the reduction of depression (Atousa, 2009). The previous study provided some support that that group physical activity may be associated with lower levels of psychological distress (including depression and anxiety) in a similar student population. Further investigation is required to examine this relationship. Therefore, the third hypothesis was that those assigned to the group jogging condition would experience greater reductions of psychological distress than those assigned to the solo jogging condition.

4.1.1 Research Questions

Will students randomly assigned to a jogging group condition engage in more jogging overall, than those assigned to a solo jogging condition?

Will students assigned to a jogging group condition engage in more physical activity overall, than those assigned to a solo jogging condition?

Will students assigned to a jogging group condition experience greater reductions of psychological distress than those assigned to the solo jogging condition?

4.2 **Methods**

This intervention compared the physical activity and psychological distress of participants allocated to a jogging group and solo jogging condition over a ten week period. Participants completed online questionnaires at baseline, after 5 and 10 weeks and recorded all jogging activity in a self-report diary. The intervention was facilitated by “JogScotland”, who organises over 400 local groups in Scotland, facilitating walk/jog/run programmes for beginners, intermediates and advanced runners. JogScotland is Scotland’s national recreational running network and provides training for jogging group leaders. JogScotland was established in 2002 and is funded by Scottish athletics (the governing body for athletics in Scotland), Sportscotland (the national agency for sport in Scotland), NHS Health Scotland and the Scottish Government Health Department. The design is explained in further depth below.

4.3 **Ethical Issues**

This project was granted ethical approval by the ethics panel from the School of Health in Social Science, University of Edinburgh (Appendix D). An important condition of this was that participants were informed and understood that the completion of the questionnaires and participation in research was with the remit of the University of Edinburgh, but any physical activity undertaken was within the remit of JogScotland. This was explicit in the participant information sheets. Leaders from JogScotland have public liability insurance and are trained to deal with health issues and injury. For example, if the leader is unsure of a participant’s health or fitness they will request that the participant attends their GP to obtain a letter indicating their suitability for participating in the scheme.

Consent forms were required due to the practical nature of the study. Signed consent forms were stored in a locked cabinet, held within the department of Clinical and Health Psychology. Participants provided their name, postal address and email address, this was only used to deliver correspondence and materials required for the intervention. Names were used to match responses throughout the three assessments.

Unique ID codes were provided for participant identification throughout analysis and no personal information was saved in data analysis files. All files containing personal information were password protected and deleted when the study was complete (in accordance with the Data Protection Act, 1998). Anonymous data were held on a computer within the university. Participants were informed in the participant information sheet that data will be kept for the duration of the PhD and then for at least five years after PhD completion along with signed consent forms. A separate file contained a list of email addresses representing the individuals who requested a summary of the study findings. No further identifying information was stored in this file. This file was deleted when study findings were sent (conforming with the Data Protection Act, 1998).

Participants were reminded that their participation in the study was voluntary and that they could leave the research or the jogging activity at any time without any negative consequences. No ethical complications or injuries occurred during this intervention.

4.4 Participants

Participants were included in the study if they were undergraduate or postgraduate students from the University of Edinburgh and over the age of 18; there was no upper age limit. To avoid a potential confound, participants were only recruited if they were inactive or engaged in low levels of physical activity at baseline, as additional physical activity beyond the jogging programme may have contributed to changes in psychological distress. Participants were sampled to engage in a beginner's jogging programme. Participants who already engaged in moderate to high intensity physical activity were permitted to join the jogging sessions but were excluded from the study and provided with further information on intermediate or advanced JogScotland programmes.

4.4.1 Recruitment

Participants were sampled from a variety of sources described below.

a) Contact Details from a Previous Questionnaire

In the previous student surbey study), participants were asked to provide their contact details if they were interested in participating in a future study. Participants were emailed and invited to participate four weeks in advance of the intervention. A reminder and further invitation followed two weeks later. Although 108 previous participants registered their interest, only two agreed to participate in the current study.

b) Leaflets and Posters

Sixteen hundred and eighty leaflets (E3) were distributed to students throughout university campus areas. Six hundred posters (E4) were placed in communal student areas, with tear off strips detailing the email address and website (www.jogresearch.co.uk) for the study.

c) Online Advertisements

An email advertising the study was sent to students of the College of Philosophy, Psychology and Language Sciences, including details of the study and contact information; 19 responded to this invitation. This information was also sent to the postgraduate research students from School of Health; two responded to this invitation.

Advertisements were placed in online communities specific to Edinburgh, such as Gumtree, Facebook and Livejournal.com. Gumtree consists of free classified advertisements categorised by city. An advertisement was placed in categories which may have interested students such as "Freebies", "Classes" "Fitness, Dance and Health" and "Groups and Associations". Facebook is an online networking and communication utility. An advertisement was placed to display to those at the University of Edinburgh, it displayed the advert 52,110 times and was clicked three times. Livejournal is an online blogging site, which contains several communities specific to students and Edinburgh residents. A post inviting participants was displayed four weeks before the start date, and followed by a reminder after two weeks. Three participants responded to this invitation.

Google Adwords was used to advertise and display the study when the search terms were used in the Google search engine "exercise, physical activity, running, jogging, group, beginner, Edinburgh, join, new, research, start, student, study, university". The advertisement was displayed 14,824 times and was clicked 4 times.

d) Personal Contact

The researcher spoke to small groups of students around campus throughout freshers week and for two weeks after, but did not recruit any participants. However a few students noted that they were aware of the study as they had received flyers previously. The researcher invited participation from the Postgraduate Student Society which resulted in 18 reports of interest. Sport based societies were not targeted as the study did not sample individuals who were already highly engaged in physical activity.

e) Word of Mouth

Eighteen individuals reported that friends had informed them about the study and expressed interest to participate.

f) Unknown

Twelve individuals emailed the researcher from unknown sources and expressed interest to participate, which may have included sources explained above.

4.4.2 Intervention Group Allocation

Recruitment resulted in 74 respondents. One week before the intervention was due to begin, respondents were emailed to confirm participation. Forty-eight individuals agreed to participate and were quasi randomised to jogging conditions. Participants were allocated alternatively to group and solo conditions on order of response. Twenty-four were quasi randomised to the group jogging condition and 24 to the solitary jogging condition. Four participants dropped out of the study before completing baseline measures, 16 participants completed baseline measurements but did not begin jogging. Twenty-eight participants (13 allocated to group and 15 to solo) completed the 10 week intervention period, (Figure 4.1).

4.4.3 Power

As no research has compared group and solitary jogging conditions in relation to psychological distress, sample size calculations were based a similar study which compared group and solitary physical activity. McGale (2011) calculated power using the predicted effect size from Mead et al.'s (2008) review of exercise on depression (Cohen's d = 0.6). Power calculations (including an effect size of 0.6, providing 80% power, $p<0.05$) indicated that a minimum of 36 participants per condition were required to detect a difference between group and solo jogging conditions.

4.5 Intervention

JogScotland facilitated the intervention and provided a training programme to develop the capacity to complete a 5k run including information on training, cool-down and warm up (B6), along with information on clothing and gear, diet and health. A website dedicated to JogScotland within the University of Edinburgh provides information on changing and showering facilities around the university (www.jogscotland.safety.ed.ac.uk/). Participants allocated to both group and solo jogging conditions were provided with this information.

The intervention duration was for 10 weeks, the first period of sessions started in June 2009 after the end of semester exams, the second from September 2009 and the third from January 2010. The latter two periods started during the second week at the beginning of the university semester. University semesters were approximately 12 weeks long followed by an exam period. The 10 week period was selected to allow students to adjust at the start of the semester and not interfere with their exams at the end. Students were encouraged to continue jogging after the end of intervention.

Participants were provided with jogging diaries to record all jogging activity and included contact details of the researcher and JogScotland.

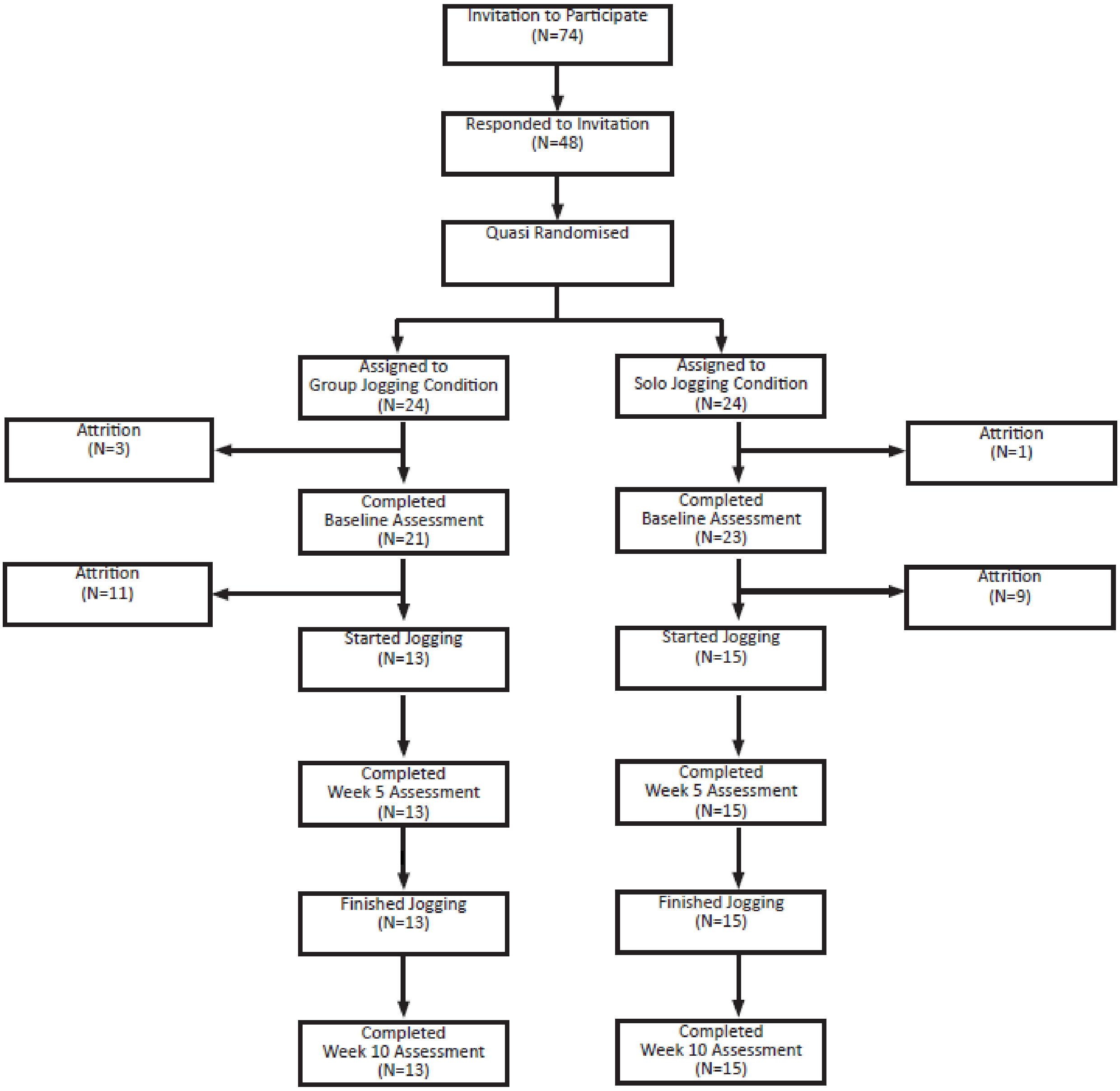

Figure 4.1 Flowchart of Participation in the Intervention

4.5.1 Group Jogging Condition

JogScotland facilitated beginner jogging sessions which were intended for individuals engaging in little or no exercise and were provided without charge. While sessions were intended to build an individual's capability to complete a 5k run, sessions were tailored to the attendees. In the current study there were often multiple leaders available to supervise different degrees of ability within the beginners' session.

JogScotland held two beginner jogging sessions per week and recommended participants to jog three times a week, either with the group session or alone. All participants were asked to engage in at least one session per week, this was to encourage motivation to take part in the study as three sessions per week may have appeared unattractive or difficult to inactive or low active individuals. These sessions were conducted in the main university campus and were open to individuals beyond the current study including university staff and students. As per instructions in the training programme, participants alternated walking and jogging for 30 seconds each, incrementally increasing the time spent jogging throughout the 10 week intervention period if possible. Jogging sessions ranged between 30 and 60 minutes, depending on the ability of the participant. Participants in the jogging group sessions benefited from motivation from others within the session, advice and feedback from the trained group session leaders.

JogScotland leaders have been trained in the practical elements of warm ups, cool downs, the coaching process (before, during and after sessions), fitness factors and session planning, goal setting, health benefits of exercise, motivation and behaviour change and risk assessment. Leaders are required to have the ability to jog for the duration for the group being led (beginners 30 minutes, intermediates 60 minutes, advanced 120 minutes) and are taught how to lead a beginners group and a mixed ability group.

4.5.2 Solo Jogging Condition

Participants allocated to the solo jogging condition were provided with the same information as those assigned to the group jogging condition including the 5k training programme and were asked to engage in at least one jogging session per week.

4.6 **Procedure**

Jogging intervention periods started in June 2009, September 2009 and January 2010. The procedure was identical for each of these time periods. Participants assigned to group and solo conditions received the same training programme and information, but those assigned to the group conditions attended sessions facilitated by JogScotland, while participants assigned to the solo condition engaged in jogging alone. All participants were asked to jog once per week and note all jogging activity in a provided jogging diary.

4.6.1 Pre-Intervention

Participants were invited to take part in the intervention using the methods detailed earlier (Section 4.4.1). On responding to the invitation, participants were asked to provide their contact details including their postal address so that a consent form (Appendix B6), participation information sheet (Appendix B7) and jogging diary (Appendix B8) could be posted to them, one week in advance of the intervention. Participants were asked to read the participant information sheet and return the consent form in a pre-addressed prepaid envelope to the researcher at the University of Edinburgh before jogging commenced.

The A5 sized jogging diary was researcher designed. The first page included the web address of the baseline questionnaire and requested that participants complete the online questionnaire before they engaged in their first jogging session. The diary also included a contact email address so that participants could contact the researcher regarding any queries or issues and contained an example of how the diary should be completed. Each page of the diary represented one week, and included space for participants to record the date and duration they jogged for, and any comments on the experience. At the bottom of the page for week 5 and 10, participants were prompted to complete the second and third online assessments and provided with the respective web addresses. Group jogging diaries included a space for participants to place attendance stickers from JogScotland leaders.

Shortly before the intervention began, all participants were emailed information containing links to the JogScotland website illustrating appropriate footwear and clothing, and training programmes. JogScotland leaders were provided with stickers (Appendix B9) to distribute to group attendees. Attendees were asked to stick these in their diary and these then provided an objective measure of attendance. Participants allocated to solo jogging were unable to receive stickers.

4.6.2 Weeks 1 to 5

In the first week participants attended either the jogging group or started their jogging alone. At the start of the fifth week participants were emailed to remind them to complete the second online assessment after five weeks of jogging (in addition there was a prompt in the jogging diaries).

4.6.3 Week 6 to End of Intervention

Likewise, at the start of the tenth week participants were reminded to complete the final online questionnaire after 10 weeks of jogging. After completion of this, participants were posted a thank you note and a stamped addressed envelope so that they could return the completed jogging diary. Participants were free to continue jogging with JogScotland after the end of the intervention; in addition participants could graduate to an intermediate jogging group.

One participant from the group condition started jogging 1 week late. Another participant from the group condition started 2 weeks late due to illness, they were instructed to complete online questionnaire and diaries from the point they started, rather than include a number of blank weeks and finish early.

4.7 Evaluation Pre- and Post-Test Measures

The questionnaire pack was completed online. All of the following measures were assessed at baseline and were completed by those in both group and solo jogging conditions. The questionnaire pack consisted of 38 items and which took approximately 30 minutes to complete. The measures included in the online questionnaire at week 5 and 10 were identical to those at baseline, excluding the researcher designed demographic questionnaire.

Most of the measures were previously outlined (Methods, Chapter 33.2.1 c), these included:

4.7.1 Demographic Questionnaire (Researcher Designed)

This measured basic demographic information including age, sex, and level of university degree.

4.7.2 International Physical Activity Questionnaire Short Version (IPAQ-Short; Booth et al., 1996)

This assessed general physical activity levels.

4.7.3 Activity context preference (Researcher Designed)

This assessed participants' preferences for group or solo physical activity.

4.7.4 Participation in group and solo activity (Researcher Designed)

This measures participants' group and solo physical activities to assess for potential confounds.

4.7.5 Depression Anxiety Stress Scale, Short Version (DASS-21, based on the full version of the DASS, Lovibond & Lovibond, 1995)

This assessed psychological distress.

4.8 Analysis

The intervention included three data collection periods beginning in June 2009, September 2009 and January 2010. At each of these periods a new jogging group was started and participants were allocated to jog alone to allow conditions to run parallel.

Chi-Square statistic indicated that there were no significant differences in gender or university degree level between the three different periods (Table 4.1). Likewise, a one-way ANOVA indicated that there were no significant differences in age, baseline psychological distress or engagement in physical activity (Table 4.2). The data were combined to create one dataset for further analysis.

The first hypothesis predicted that those assigned to the jogging group condition would engage in more jogging activity than those assigned to the solo jogging condition. Jogging activity was measured using self-report diaries reporting the frequency and duration of jogging sessions. Intensity of jogging was identified as 7.0 METs using Ainsworth et al.'s (2002) compendium of physical activities, detailing their MET intensity scores. Quantity of jogging was defined as 7.0 x duration x frequency. This was calculated for amount of jogging per week, and totalled representing the total amount of jogging engaged in throughout the 10 week period. T-test analysis compared the difference of the amount of jogging behaviour between group and solo jogging conditions.

The second hypothesis predicted that those assigned to the jogging group condition would engage in more physical activity than those assigned to the solo jogging condition. Physical activity was measured using the IPAQ and represented the previous week's activity at baseline, week 5 and 10. T-test analysis compared the difference in the amount of physical activity between group and solo jogging condition after 5 and 10 weeks. A mixed ANOVA compared the physical activity between conditions at baseline, 5 and 10 weeks and differences between conditions.

The third hypothesis predicted that those assigned to the group jogging condition would experience greater reductions of psychological distress than those assigned to the solo jogging condition. Psychological distress was assessed using the DASS, which was expressed as depression, stress, anxiety and as a totalled overall measure of psychological distress. T-tests compared the difference in the psychological distress between group and solo jogging condition after 5 and 10 weeks. A mixed ANOVA compared the change in psychological distress between conditions at baseline, 5 and 10 weeks.

Table 4.1 Frequencies of Gender and Level of Degree throughout Three Data Collection Periods

		Session 1 (June 2009)		Session 2 (September 2009)		Session 3 (January 2010)		Difference Between Samples (Chi-Square)
		Frequency	%	Frequency	%	Frequency	%	
Sex	Male	1	10.0	0	0	1	9.1	χ^2(2, N=28) = 0.72, p=0.70
	Female	9	90.0	7	100.0	10	90.9	
	Total	10	100.0	7	100.0	11	100.0	
Degree Level *	Ph.D.	3	30.0	2	28.6	2	18.2	χ^2(4, N=28) = 2.27, p=0.69
	Masters	6	60.0	4	57.1	9	81.8	
	Undergraduate	1	10.0	1	14.3	0	0	
	Total	10	100.0	7	100.0	11	100.0	

* All participants were university students

Table 4.2Baseline Characteristics throughout Three Data Collection Periods

	Session 1			Session 2			Session 3			Difference Between Samples (ANOVA)
	N	Mean	SD	N	Mean	SD	N	Mean	SD	
Age	10	24.80	4.10	7	25.14	3.58	11	24.82	1.89	F(2,25)= 0.03, p=0.97
Depression	10	0.70	1.57	7	1.29	2.21	11	0.73	1.10	F(2,25)= 0.34, p=0.72
Stress	10	0.90	1.85	7	0.71	0.95	11	0.91	1.38	F(2,25)= 0.04, p=0.96
Anxiety	10	3.00	2.45	7	3.00	2.94	11	4.45	3.21	F(2,25)= 0.85, p=0.44
Psychological Distress (DASS)	10	4.60	4.99	7	5.00	3.83	11	6.09	4.18	F(2,25)= 0.32, p=0.73
Vigorous Physical Activity	10	200.00	245.85	7	182.86	188.83	11	116.36	172.93	F(2,25)= 0.48, p=0.63
Moderate Physical Activity	10	56.00	63.10	7	148.57	167.67	11	60.00	103.92	F(2,25)= 1.72, p=0.20
Walking Activity	10	417.45	308.79	7	377.14	328.82	11	351.00	243.96	F(2,23)= 0.14, p=0.87
Total Physical Activity (IPAQ)	10	673.45	320.52	7	708.57	618.07	11	527.36	309.18	F(2,25)= 0.53, p=0.60

4.9 **Results**

4.9.1 Baseline characteristics of non-competers versus completers

Forty eight individuals agreed to participate in the intervention, however 4 dropped out before completion of baseline measures, 16 dropped out after completion of baseline measures and 28 took part in the jogging intervention. The characteristics of individuals who took part in the intervention (n=28) were compared with those who completed only baseline measures and did not engage in any jogging activity (n=16).

There were no significant differences in age or degree between non-completers and completers (Table 4.3). However non-completers were significantly more depressed, stressed, and demonstrated greater overall psychological distress than those who took part in the intervention ((Table 4.4). Furthermore, non-completers engaged in significantly less vigorous and moderate activity, less walking and less overall physical activity (Table 4.4).

Table 4.3 Frequencies of Sex and Degree Level of Jogging Activity Completers and Non-Completers

		Non-Completers		Completers		Difference Between Physical Activity Categories (Chi-Square)
		Frequency	%	Frequency	%	
Sex	Male	0	0	2	7.1	χ^2 (1, N=44)=1.20, p=0.27
	Female	16	100.0	26	92.9	
	Total	16	100.0	28	100.0	
Degree Level	Ph.D.	7	43.8	7	25.0	χ^2 (2, N=44)=2.45, p=0.29
	Masters	7	43.8	19	67.9	
	Undergraduate	2	12.5	2	7.1	
	Total	16	100.0	28	100.00	

Table 4.4 Characteristics of Participants who Engaged in Jogging Activity and Non-Engagers

	Non-Completers			Completers			Differences Between Samples (T-Test)
	N	Mean	SD	N	Mean	SD	
Age	16	25.50	3.58	28	24.89	3.13	t(42=0.59, p=0.56
Depression	16	3.38	3.58	28	0.86	1.56	t(18.31)=2.68, p=0.02
Stress	16	5.88	3.500	28	0.86	1.43	t(17.92)=5.48, p<0.01
Anxiety	16	3.81	3.953	28	3.57	2.87	t(42)=0.23, p=0.82
Psychological Distress	16	13.06	10.36	28	5.29	4.30	t(18.01)=2.87, p=0.01
Vigorous Physical Activity	16	0.00	0.00	28	162.86	201.60	t(27)=4.28, p<0.01
Moderate Physical Activity	16	7.50	30.00	28	80.714	114.76	t(33.00)=3.19, p<0.01
Walking	16	148.50	207.66	28	381.27	280.57	t(42)=2.89, p<0.01
Total Physical Activity (IPAQ)	16	156.00	222.64	28	624.84	401.38	t(42)=4.30, p<0.01

4.9.2 Baseline characteristics

Twenty eight participants completed the intervention, and there were no significant differences in psychological distress (and subscales) and physical activity levels (as measured by the IPAQ) at baseline between those assigned group (n=15) and solo jogging conditions (n=13 Table 4.5).

Participants demonstrated mild psychological distress in comparison to a student sample and the general population (Bayram & Bilgel, 2007; Henry & Crawford, 2005). Bayram and Bilgel (2007) described the following subscales as mild; depression (M=10.03, SD=6.88), stress (M=14.92, SD=6.71) and anxiety (M=9.83, SD=5.94) from a sample of 1617 university students. Baseline psychological distress was more similar to Henry and Crawford's (2005) findings of depression (M=2.83, SD=3.87), stress (M=4.73, SD=4.20) and anxiety (M= 1.88, SD=2.95) from a sample of 1794 members of the general population.

The difference in physical activity levels between conditions was not significant, however those assigned to the group jogging condition demonstrated greater amounts of physical activity than those assigned to the solo jogging condition (Table 4.5).

Table 4.5 Baseline Characteristics and Differences between Group and Solo Jogging Conditions

	Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (T-Test)
	N	Mean	SD	N	Mean	SD	
Depression	15	1.00	2.00	13	0.69	0.85	t(26)= 0.51, p=0.61
Stress	15	0.80	1.66	13	0.92	1.19	t(26)= 0.22, p=0.83
Anxiety	15	3.47	3.02	13	3.69	2.81	t(26)=0.20, p=0.84
Psychological Distress (DASS)	15	5.27	4.96	13	5.31	3.59	t(26)= 0.03, p=0.98
Vigorous Physical Activity	15	130.67	174.01	13	200.00	230.94	t(26)= 0.91, p=0.37
Moderate Physical Activity	15	70.67	128.03	13	92.31	101.17	t(26)= 0.49, p=0.63
Walking Activity	15	335.50	286.04	13	434.08	275.72	t(26)= 0.93, p=0.36
Total Physical Activity (IPAQ)	15	536.83	449.79	13	726.38	324.96	t(26)= 1.26, p=0.22

Table 4.6 Frequencies of Sex and Level of Degree throughout Three Data Collection Periods

		Inactive/Low Active		Moderate Active		Difference Between Physical Activity Categories (Chi-Square)
		Frequency	%	Frequency	%	
Sex	Male	1	6.7	1	7.7	χ^2 (2, N=28) = 0.72, p=0.29
	Female	14	93.3	12	92.3	
	Total	15	100.0	13	100.0	
Degree Level	Ph.D.	3	20.0	4	30.8	χ^2 (1, N=28) = 1.87, p=0.17
	Masters	11	73.3	8	61.5	
	Undergraduate	1	6.7	1	7.7	
	Total	15	100.0	13	100.0	

Table 4.7 Baseline Characteristics and Differences between Inactive/Low Active and Moderately Active Participants

	Inactive/Low Active			Moderate Active			Differences Between Categorises (T-Test)
	N	Mean	SD	N	Mean	SD	
Age	15	25.00	3.68	13	24.77	2.49	t(26)=0.29, p=0.78
Depression	15	0.60	1.59	13	1.15	1.52	t(26)=0.51, p=0.61
Stress	15	0.60	1.06	13	1.15	1.77	t(26)=0.22, p=0.83
Anxiety	15	4.07	2.91	13	3.00	2.83	t(26)=0.20, p=0.84
Psychological Distress (DASS)	15	5.27	3.65	13	5.31	5.11	t(26)=0.03, p=0.98
Vigorous Physical Activity	15	82.67	142.20	13	255.38	224.82	t(26)=0.91, p=0.37
Moderate Physical Activity	15	30.67	57.00	13	138.46	138.19	t(26)=0.50, p=0.63
Walking Activity	15	215.60	141.59	13	572.42	282.55	t(26)=0.93, p=0.36
Total Physical Activity (IPAQ)	15	328.93	190.68	13	966.27	290.39	t(26)=1.26, p=0.22

While the intervention was aimed at individuals who were inactive or low active, the amount of physical activity that participants engaged in ranged from 0 to 1790 MET-min/week. The IPAQ scoring protocol categorises physical activity in excess of 600 MET-min/week as moderate, and 3000 MET-min/week as high. Therefore, only 15 participants (10 assigned to solo, 5 to group) were identified as low active or inactive. There were no significant differences at baseline (Table 4.6, Table 4.7) between inactive/low and moderately active individuals.

4.9.3 Hypothesis 1

Those assigned to the jogging group condition will engage in more jogging activity than those assigned to the solo jogging condition.

Jogging diaries were completed and returned by all participants. The diaries documented the frequency and duration of jogging activity on a weekly basis for over a 10 week period (Table 4.8, Table 4.9). Some participants allocated to the group jogging condition engaged in additional solitary jogging. They appeared to compensate for group nonattendance with solitary jogging (for example, week 5, Table 4.10). The frequency and duration of all jogging (both group and solitary) of those assigned to the group jogging condition were combined and compared to the amount of jogging engaged in by participants assigned to the solo jogging condition.

There was not a significant difference between the frequency of jogging sessions of those assigned to the group jogging condition (M=8.00, SD=2.58) and solo jogging condition (M=7.20, SD=2.01) over the 10 week intervention period, (χ^2 (8, N=28) = 8.09, p=0.64). Likewise there was not a significant difference between the amount of time spent jogging throughout the 10 week period of those assigned to the group jogging condition (M=261.67, SD=87.24) and solo condition (M=238.67, SD=81.36), (t(25)= 0.71, p=0.49).

The MET-min/week was calculated (frequency x duration x 7.0) and confirmed there was no significant difference in jogging activity between those assigned to the group jogging condition (M=2215.81, SD=1037.81), and those assigned to the solo jogging condition (M=1792.00, SD=750.80), t(26)=1.25, p=0.22 (Figure 44.2). Although the difference was not significant, participants assigned to the group jogging condition engaged in more jogging activity than those assigned to jog solo which appeared to be related to the additional solitary jogging that these individuals engaged in.

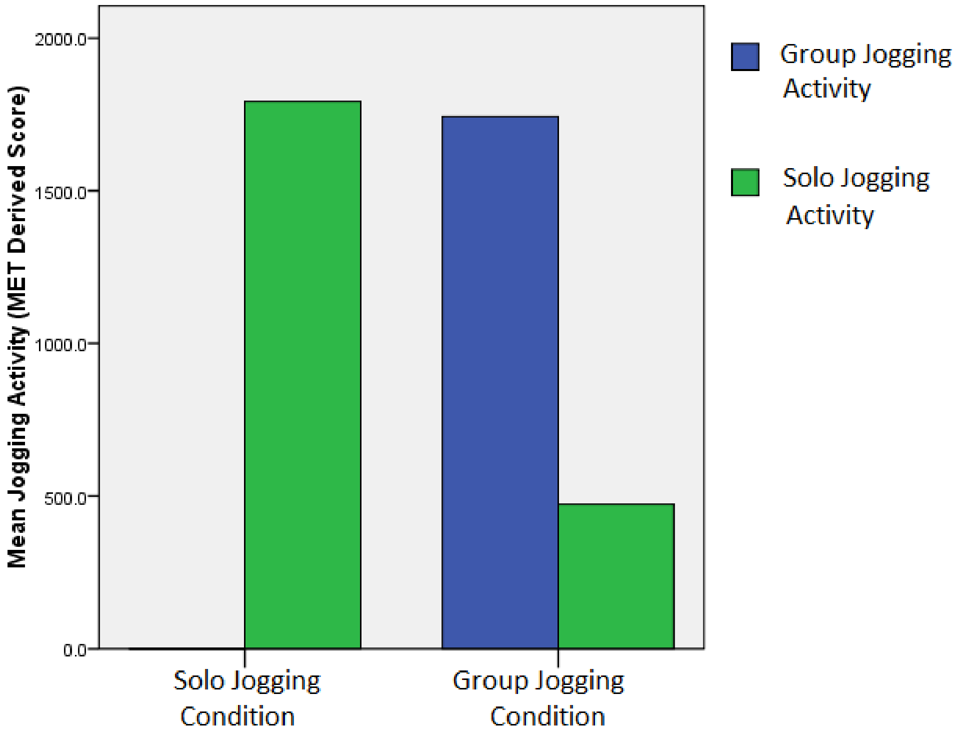

Figure 44.2 Mean Jogging Activity Performed by Participants in Group Jogging and Solo Jogging Conditions

Table 4.8 Mean Amount of Jogging Performed by Participants Allocated to Group Jogging Condition

	Group Jogging						Additional Solitary Jogging					
	Duration (Mins)		Frequency Per Week		MET-min/week		Duration (Mins)		Frequency Per Week		MET-min/week	
Week	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	38.46	17.72	0.92	0.49	301.54	198.78	0.77	2.77	0.08	0.28	5.38	19.41
2	37.69	24.88	0.85	0.69	312.31	340.38	0.00	0.00	0.00	0.00	0.00	0.00
3	34.23	19.56	0.92	0.64	288.08	201.64	1.54	5.55	0.08	0.28	10.77	38.83
4	17.31	22.79	0.46	0.66	145.38	207.97	11.92	18.88	0.31	0.48	83.46	132.15
5	11.25	20.35	0.31	0.48	72.69	138.14	18.46	18.97	0.85	0.38	129.23	132.80
6	9.23	17.89	0.23	0.44	64.62	125.26	16.92	14.37	0.62	0.51	118.46	100.57
7	19.62	26.26	0.46	0.66	169.62	259.11	8.46	11.44	0.38	0.51	59.23	80.05
8	15.00	23.72	0.38	0.65	137.31	251.36	5.00	10.00	0.23	0.44	35.00	70.00
9	15.00	23.72	0.38	0.65	137.31	251.36	3.85	9.61	0.15	0.38	26.92	67.25
10	11.54	22.21	0.31	0.63	113.08	247.96	0.77	2.77	0.08	0.28	5.38	19.41
Total	188.33	118.75	5.23	3.63	1741.92	1253.51	67.69	47.11	2.76	1.54	473.85	329.76

	Combined Group and Solitary Jogging					
	Duration (Mins)		Frequency Per Week		MET-min/week	
	Mean	SD	Mean	SD	Mean	SD
1	39.23	18.24	1.00	0.58	306.92	200.12
2	37.69	24.88	0.85	0.69	312.31	340.38
3	35.77	17.30	1.00	0.58	298.85	188.27
4	29.23	20.70	0.77	0.60	228.85	185.54
5	31.25	16.80	1.15	0.38	201.92	127.92
6	26.15	13.72	0.85	0.38	183.08	96.02
7	28.08	24.71	0.85	0.69	228.85	243.17
8	20.00	22.36	0.62	0.65	172.31	240.14
9	18.85	26.07	0.54	0.78	164.23	258.93
10	12.31	21.95	0.38	0.65	118.46	246.06
Total	261.67	87.34	8.00	2.58	2215.77	1037.81

Table 4.9 Mean Amount of Jogging Performed by Participants Allocated to Solo Jogging Condition

	Solo Jogging					
	Duration (Mins)		Frequency Per Week		MET-min/week	
Week	Mean	SD	Mean	SD	Mean	SD
1	34.33	12.37	0.93	0.26	240.33	86.61
2	31.33	16.20	1.07	0.46	275.33	242.44
3	28.33	15.55	0.93	0.46	226.33	192.10
4	27.00	23.96	0.60	0.51	189.00	167.75
5	32.67	19.99	0.87	0.35	228.67	139.92
6	24.00	17.85	0.80	0.56	186.67	159.11
7	17.00	19.25	0.53	0.52	119.00	134.78
8	9.67	15.17	0.33	0.49	67.67	106.22
9	20.33	22.00	0.60	0.63	161.00	185.58
10	14.00	15.14	0.53	0.52	98.00	106.00
Total	238.67	81.36	7.20	2.01	1792.00	750.81

Table 4.10 Number of Participants Allocated to Jogging Group Condition Who Attended Group and Engaged in Additional Solitary Jogging At Least Once per Week

Week	Number of Participants Who Did Not Attend Jog Group	Number of Participants Who Attended Jog Group	Number of Participants Who Engaged in Additional Solitary Jogging
1	2	11	1
2	4	9	0
3	3	10	1
4	8	5	4
5	9	4	11
6	10	3	8
7	8	5	5
8	9	4	3
9	9	4	2
10	10	3	1

A repeated measures ANOVA demonstrated no significant interaction between jogging activity over 10 weeks between group and solo jogging conditions, (Wilks' Lambda = 0.72, F(9,18)= 0.78, p=0.64, Figure4.3). Likewise, there was not a significant main effect (Wilks' Lambda = 0.53, F(9, 18)= 1,78, p=0.14).

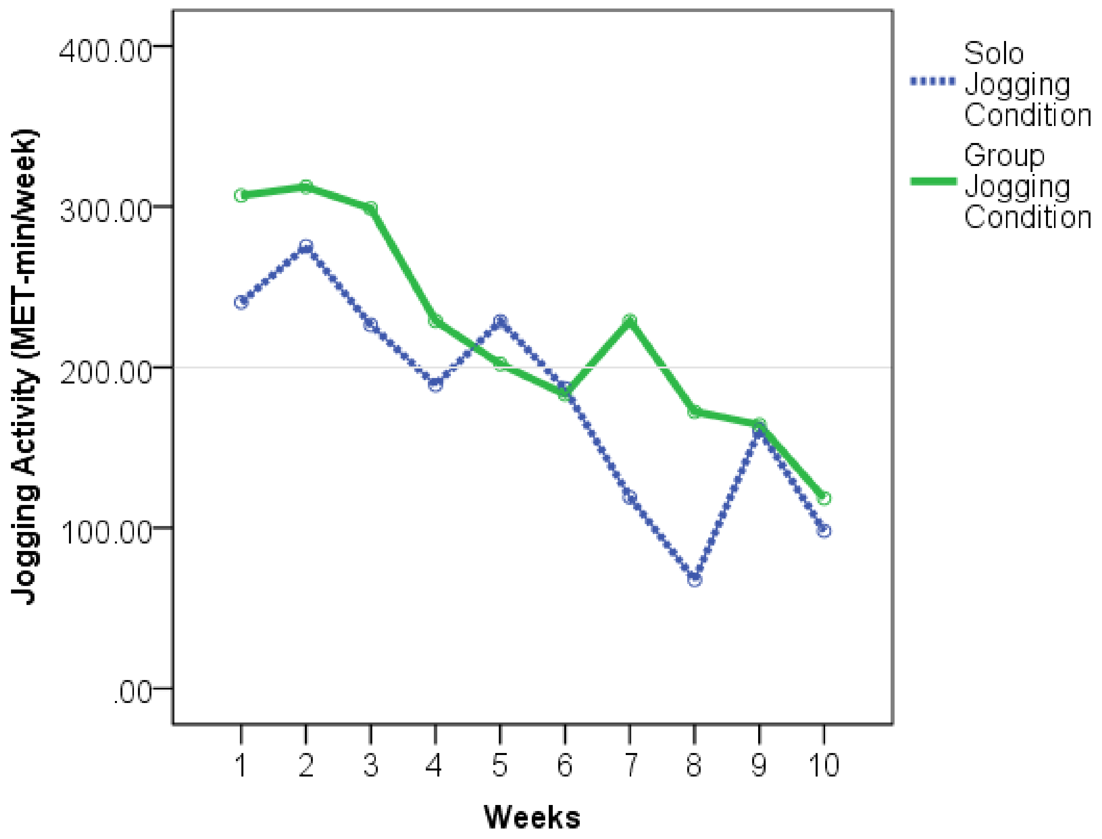

Figure4.3 Mean Jogging Activity throughout Ten Week Intervention Period

4.9.4 Comparison of total jogging activity in inactive/low active versus moderately active participants

Due to low sample size and power per category, Mann Whitney U statistic was used to examine differences in jogging activity between group and solo condition assignment in moderately and inactive/low active participants (Table4.11, Table4.12). There were no significant differences in jogging activity between group and solo conditions except for inactive/low active individuals where in week one group joggers engaged in significantly more jogging activity than solo joggers.

A repeated measures ANOVA could not be completed for any of the analyses due to the assumptions of the test not being met. However inactive/low active participants assigned to the jogging group condition appeared to engage in more jogging activity than those in the solo jogging condition (Figure 4.4).

Table4.11 Characteristics of Total Jogging Activity Categorised by Inactive/Low and Moderately Active

Physical Activity Category At Baseline		Solo Jogging Condition			Group Jogging Condition			Differences between group and Solo Jogging Activity (Chi-Square, Mann Whitney U)
		N	Mean	SD	N	Mean	SD	
Inactive/Low	Frequency	10	7.20	2.04	5	9.00	3.162	χ^2(6, N=15) = 4.13, p=0.66
	Duration (Mins)	10	235.00	63.25	4	280.00	81.34	U= 15.5, p=0.254
	Jogging Activity (MET-min/week)	10	1743.00	564.07	5	2723.00	1296.99	U= 19.50, p=0.94
Moderate	Frequency	5	7.20	2.17	8	7.38	2.134	χ^2 (5, N=13) = 3.85, p=0.57
	Duration (Mins)	5	246.00	118.61	8	252.50	94.00	U= 19.5, p=0.94
	Jogging Activity (MET-min/week)	5	1890.00	1113.14	8	1898.75	765.84	U= 12.50, p=0.30

Table4.12 Jogging Activity (min-MET/week) of Moderate and Inactive/Low Active Individuals Between Group and Solo Conditions

Physical Activity Category At Baseline	Week	Solo Jogging Condition			Group Jogging Condition			Difference between Conditions (Mann Whitney)
		N	M	SD	n	M	SD	
Moderate	1	5	245.00	137.80	8	297.50	259.90	U=18.50, p=0.83
	2	5	336.00	309.71	8	310.63	168.83	U=18.50, p=0.83
	3	5	224.00	351.40	8	271.25	201.28	U=14.00, p=0.44
	4	5	147.00	204.68	8	214.38	136.76	U=17.50, p=0.72
	5	5	280.00	107.88	8	183.75	127.92	U=11.50, p=0.22
	6	5	189.00	76.68	8	153.13	108.99	U=18.00, p=0.83
	7	5	154.00	174.30	8	201.25	176.25	U=17.00, p=0.72
	8	5	70.00	98.99	8	122.50	142.48	U=16.00, p=0.62
	9	5	133.00	136.46	8	105.00	148.49	U=17.50, p=0.72
	10	5	112.00	106.16	8	39.38	111.37	U=12.00, p=0.28
	Total	5	1890.00	1113.14	8	1898.75	765.84	U=20.00, p>0.99
Inactive/Low	1	10	238.00	56.68	5	322.00	38.34	U=6.000, p=0.02
	2	10	245.00	213.85	5	315.00	545.60	U=19.00, p=0.51
	3	10	227.50	50.18	5	343.00	177.43	U=11.00, p=0.10
	4	10	210.00	153.89	5	252.00	263.55	U=21.00, p=0.68
	5	10	203.00	151.94	5	231.00	136.90	U=20.50, p=0.59
	6	10	185.50	191.74	5	231.00	46.96	U=20.50, p=0.59
	7	10	101.50	117.19	5	273.00	345.07	U=17.50, p=0.37
	8	10	66.50	114.84	5	252.00	352.96	U=16.50, p=0.31
	9	10	175.00	211.29	5	259.00	379.87	U=23.50, p=0.86
	10	10	91.00	110.93	5	245.00	356.93	U=20.50, p=0.59
	Total	10	1743.00	564.07	5	2723.00	1296.98	U=12.00, p=0.13

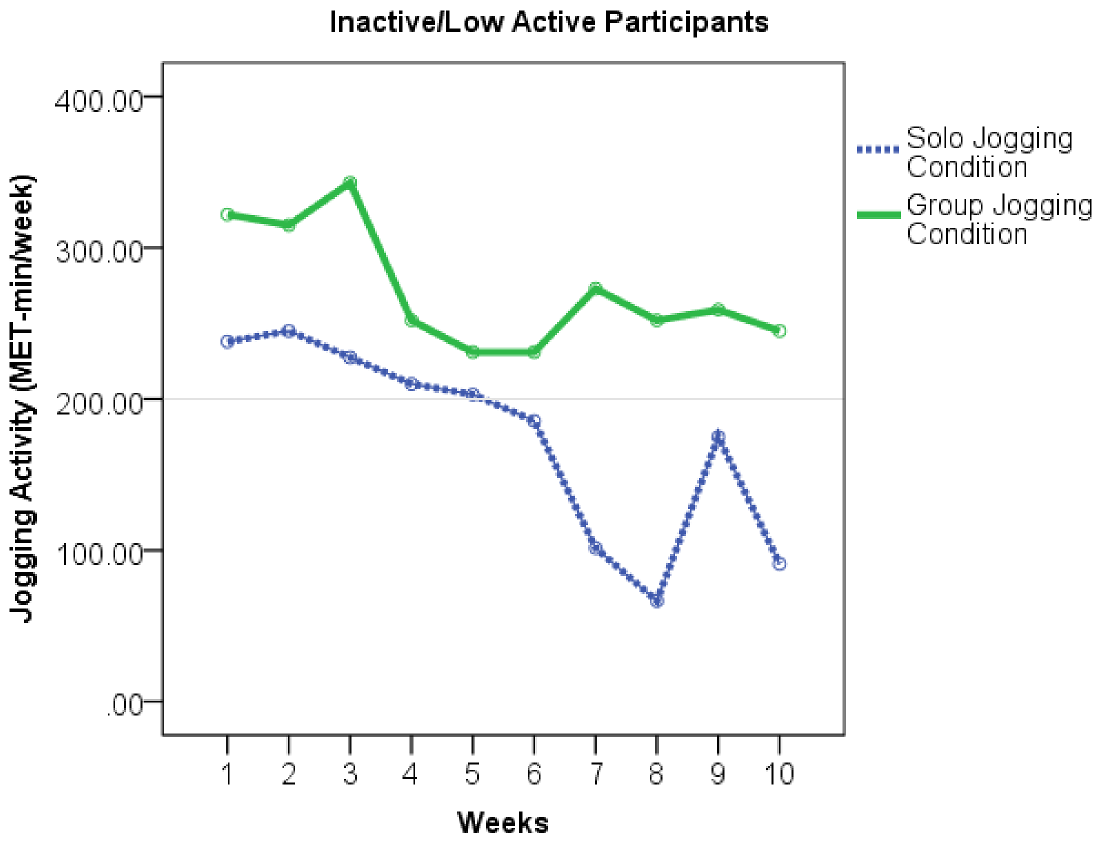

Figure 4.4 Mean Jogging Activity of Participants Categorised as Inactive/Low Active

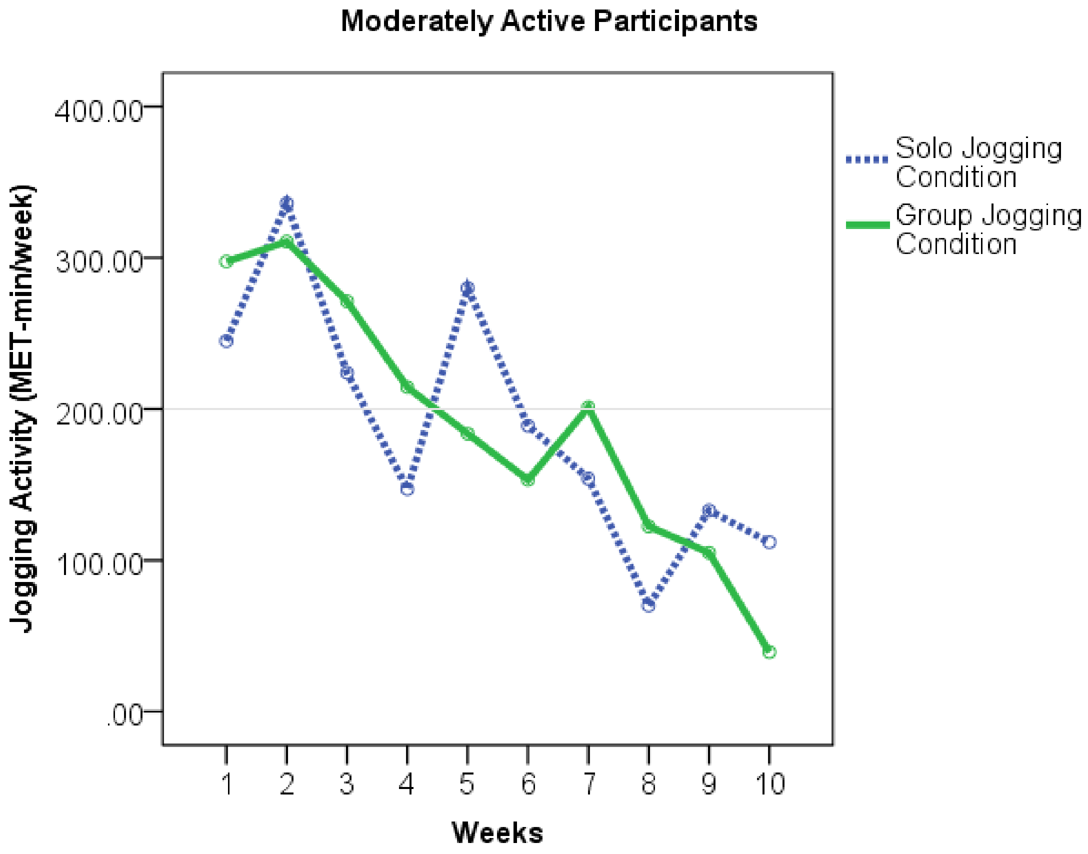

Figure 4.5 Mean Jogging Activity of Participants Categorised as Moderately Active

4.9.5 Hypothesis 2

Those assigned to the group jogging condition will engage in more physical activity than those assigned to the solo jogging condition

There was not a significant difference in physical activity (as measured by the IPAQ) at baseline (Table 4.13) between group and solo jogging conditions. However, participants assigned to the group jogging condition appeared to engage in more physical activity at baseline than those assigned to the solo jogging condition (difference = 189.55 MET-min/week, which is similar to 60 minutes of walking).

Overall there was not a significant difference in total physical activity from baseline to 10 weeks, however those assigned to the group jogging condition engaged in more activity (difference = 195.31 MET-min/week). However there were only two significant differences in physical activity between conditions (Table 4.13). At both week 5 and week 10, participants assigned to the group jogging conditions engaged in significantly more moderate physical activity than those assigned to the solo jogging condition (difference = 109.33 MET-min/week and 68.82 MET-min/week, respectively).

A repeated measures ANOVA could not be completed for any of the analyses due to the assumptions of the test not being met.

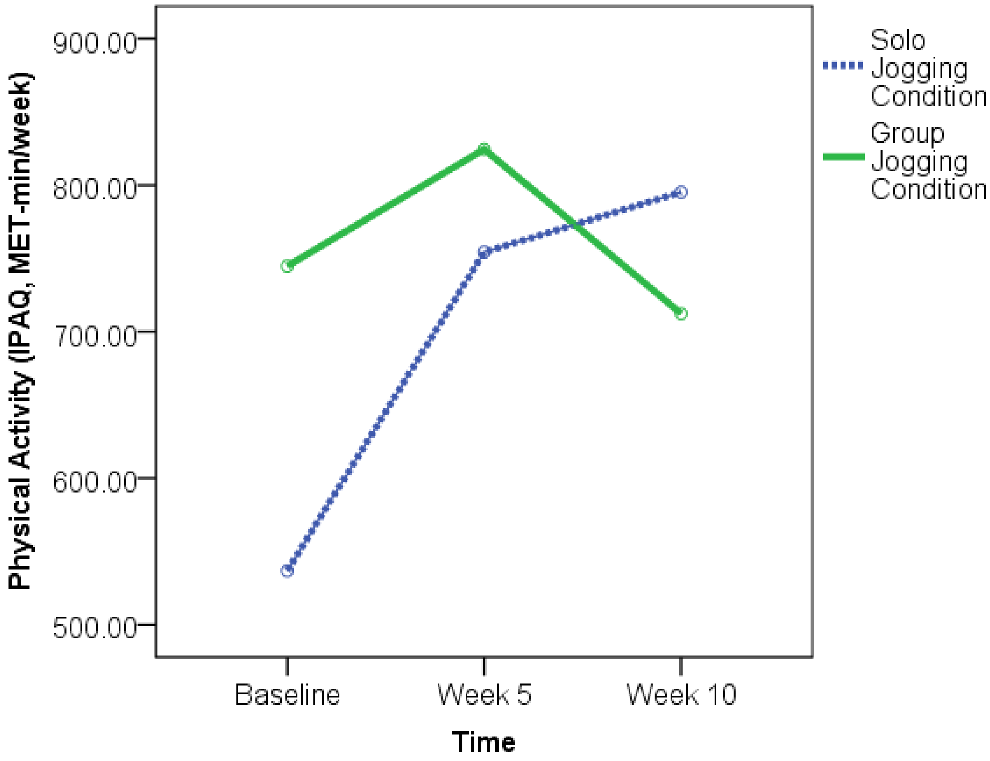

Figure 4.6 Mean Physical Activity of Group and Solo Jogging Conditions throughout Intervention

Table 4.13 Characteristics of Physical Activity as Measured by the IPAQ between Group and Solo Jogging Conditions (MET-min/week)

		Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (T-Test)
		N	Mean	SD	N	Mean	SD	
Baseline	Vigorous Activity	15	130.67	174.01	13	200.00	230.94	t(26)=0.91, p=0.37
	Moderate Activity	15	70.67	128.03	13	92.31	101.17	t(26)=0.49, p=0.63
	Walking	15	335.50	286.04	13	434.08	275.72	t(26)=0.93, p=0.36
	Physical Activity	15	536.83	449.79	13	726.38	324.96	t(26)=1.26, p=0.22
Week 5	Vigorous Activity	15	210.67	257.67	11	134.55	230.67	t(24)=0.78, p=0.45
	Moderate Activity	15	70.67	79.59	11	180.00	122.31	t(24)=2.76, p=0.01
	Walking	15	473.00	433.63	11	510.00	436.83	t(24)=0.21, p=0.83
	Physical Activity	15	754.33	571.64	11	824.55	430.54	t(24)=0.34, p=0.74
Week 10	Vigorous Activity	15	325.33	401.67	13	243.08	259.47	t(26)=0.63, p=0.53
	Moderate Activity	15	57.33	60.88	13	126.15	67.02	t(26)=2.85, p=0.01
	Walking	15	412.50	375.59	13	456.92	322.24	t(26)=0.33, p=0.74
	Physical Activity	15	795.17	685.63	13	826.15	404.82	t(26)=0.14, p=0.89
	Totaled Physical Activity	15	2086.33	1457.70	11	2281.64	869.41	t(23.23)=0.42, p=0.67

4.9.6 Physical activity categories (Comparison between inactive/low active versus moderately active)

Within the solo jogging condition, moderately active participants demonstrated significantly more vigorous activity, walking and overall physical activity than inactive/low active participants at baseline (Table 4.14). At week 5, moderately active participants demonstrated significantly more walking and overall physical activity than inactive/low active participants. However at week 10, there were no significant differences in physical activity between moderate and low and inactive participants.

Within the group jogging conditions, moderately active participants demonstrated significantly more vigorous activity, and overall physical activity than participants categorised as inactive/low active at baseline. At week 5 and 10, there were no significant differences in physical activity.

A repeated measures ANOVA could not be completed for any of the analyses due to the assumptions of the test not being met. However all participants categorised as inactive or low active appeared to increase their physical activity levels throughout the 10 week intervention period (Figure 4.7), where moderately active participants maintained or reduced their physical activity levels (Figure 4.8).

Table 4.14 Differences of Characteristics of Physical Activity Between Group and Solo Jogging Condition Assignment

Physical Activity Level			Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (T-Test)
			N	Mean	SD	N	Mean	SD	
Moderate	Baseline	Vigorous Activity	5	296.00	177.99	8	230.00	258.13	U=14.00, p=0.44
		Moderate Activity	5	120.00	207.85	8	150.00	87.51	U=12.50, p=0.28
		Walking	5	617.10	350.33	8	544.50	253.78	U=19.00, p=0.94
		Physical Activity	5	1033.10	435.20	8	924.50	176.49	U=18.00, p=0.83
	Week 5	Vigorous Activity	5	344.00	279.43	7	160.00	265.33	U=10.00, p=0.27
		Moderate Activity	5	100.00	107.70	7	191.43	145.99	U=10.50, p=0.27
		Walking	5	897.60	252.83	7	608.14	432.21	U=10.50, p=0.27
		Physical Activity	5	1341.60	292.06	7	959.57	359.43	U=7.00, p=0.11
	Week 10	Vigorous Activity	5	496.00	471.25	8	225.00	260.05	U=12.00, p=0.28
		Moderate Activity	5	80.00	48.99	8	125.00	58.31	U=11.00, p=0.22
		Walking	5	544.50	301.10	8	445.50	331.53	U=17.50, p=0.72
		Physical Activity	5	1120.50	604.93	8	795.50	423.21	U=12.00, p=0.28
	TOTAL	Physical Activity	5	3495.20	825.59	7	2579.00	760.87	U=6.00, p=0.07
Low	Baseline	Vigorous Activity	10	48.00	101.19	5	152.00	196.77	U=16.00, p=0.31
		Moderate Activity	10	46.00	65.35	5	0.00	0.00	U=15.00, p=0.25
		Walking	10	194.70	81.50	5	257.40	227.92	U=20.50, p=0.59
		Physical Activity	10	288.70	159.05	5	409.40	241.23	U=14.50, p=0.21
	Week 5	Vigorous Activity	10	144.00	231.86	4	90.00	180.00	U=18.00, p=0.84
		Moderate Activity	10	56.00	63.10	4	160.00	80.00	U=6.00, p=0.05
		Walking	10	260.70	337.42	4	338.25	447.94	U=19.50, p=0.95
		Physical Activity	10	460.70	427.79	4	588.25	492.45	U=18.50, p=0.84
	Week 10	Vigorous Activity	10	240.00	357.77	5	272.00	286.22	U=22.00, p=0.77
		Moderate Activity	10	46.00	65.35	5	128.00	86.72	U=11.00, p=0.10
		Walking	10	346.50	405.73	5	475.20	344.21	U=18.00, p=0.44
		Physical Activity	10	632.50	693.11	5	875.20	416.32	U=13.00, p=0.17

Physical Activity Level			Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (T-Test)
			N	Mean	SD	N	Mean	SD	
	TOTAL	Physical Activity	10	1381.90	1161.19	4	1761.25	891.24	U=15.00, p=0.54

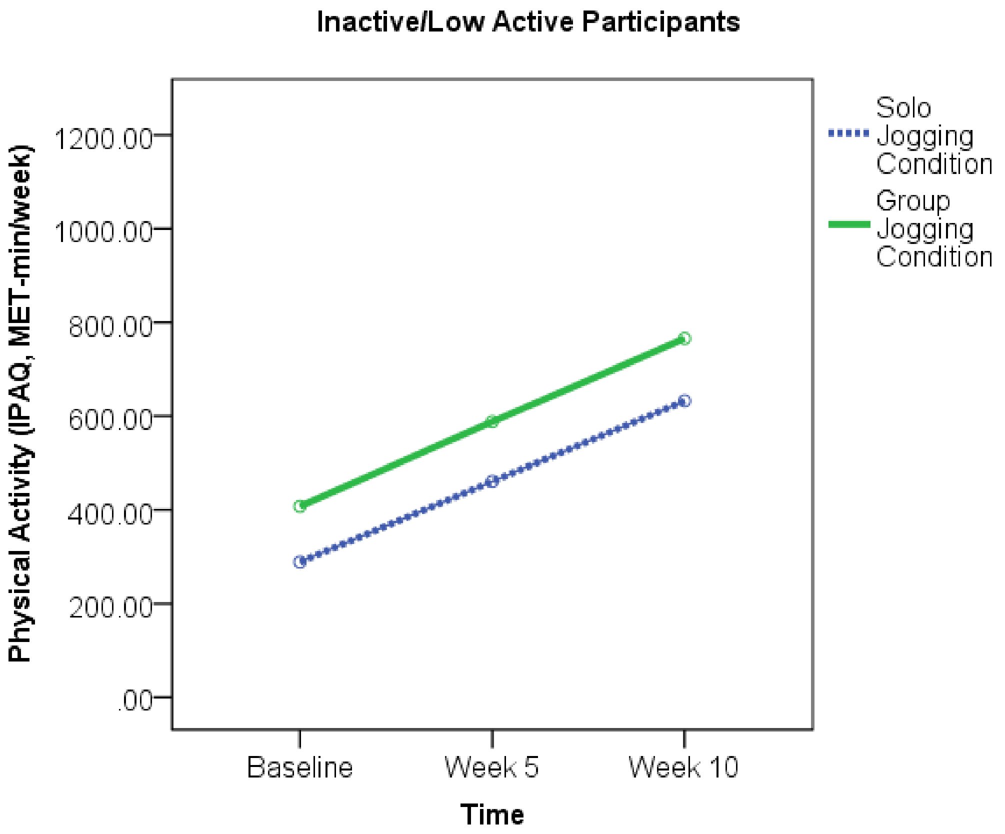

Figure 4.7 Mean Physical Activity of Group and Solo Jogging Conditions throughout Intervention Categorised as Inactive/Low Active

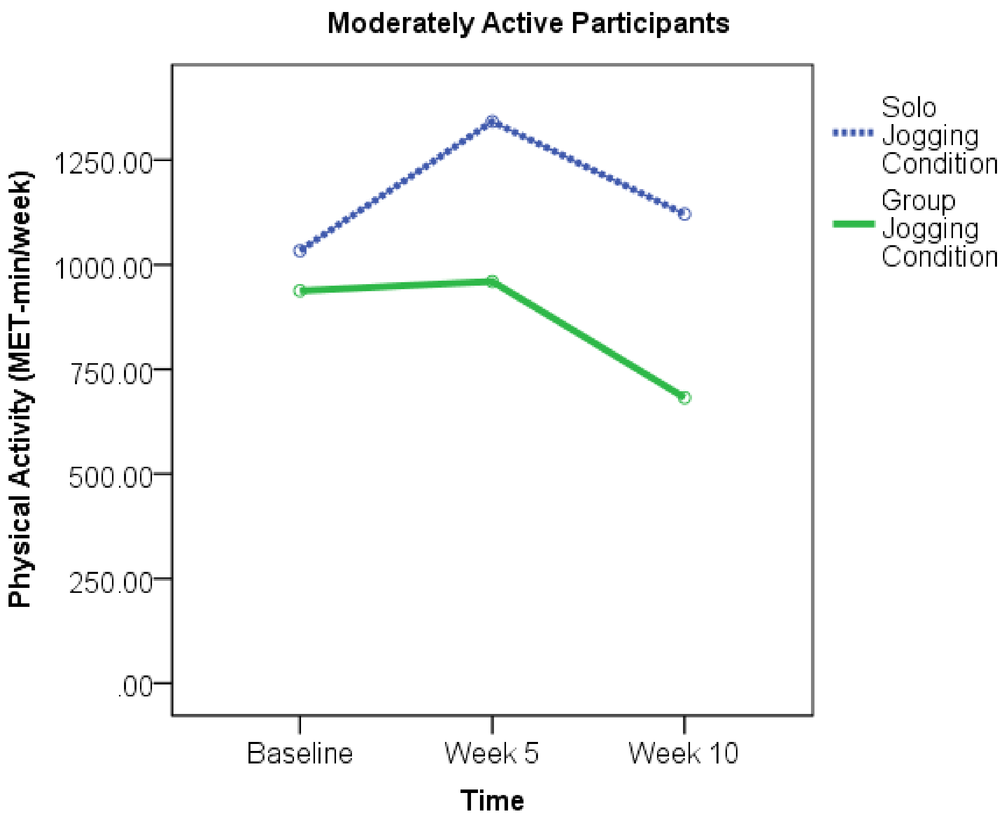

Figure 4.8 Mean Physical Activity of Group and Solo Jogging Conditions throughout Intervention Categorised as Moderately Active

4.9.7 Hypothesis 3

Those assigned to the group jogging condition will experience greater reductions of psychological distress than those assigned to the solo jogging condition

A repeated measures ANOVA could not be completed for any of the analyses due to the assumptions of the test not being met. However there appeared to be a greater increase in psychological distress for those assigned to the group jogging condition compare to those in the solo jogging condition.

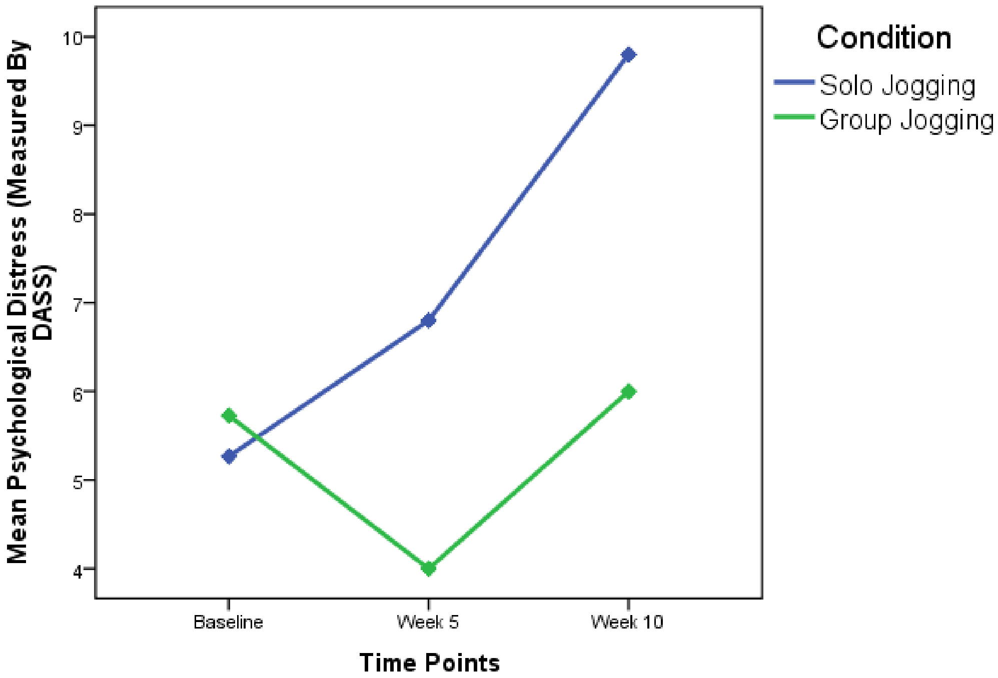

Figure 4.9 Comparison of Psychological Distress between Group and Solo Joggers over 10 weeks

Table 4.15 Characteristics of Psychological Distress between Group and Solo Jogging Conditions

		Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (T-Test)
		N	Mean	SD	N	Mean	SD	
Baseline	Depression	15	1.00	2.000	13	0.69	0.855	t(26)=0.51, p=0.61
	Stress	15	0.80	1.656	13	0.92	1.188	t(26)=0.22, p=0.83
	Anxiety	15	3.47	3.021	13	3.69	2.810	t(26)=0.20, p=0.84
	Psychological Distress	15	5.27	4.964	13	5.31	3.591	t(26)=0.03, p=0.98
Week 5	Depression	15	1.47	2.264	11	1.09	0.831	t(18.74)=0.59, p=0.56*
	Stress	15	1.20	1.612	11	0.73	0.905	t(24)=0.87, p=0.39
	Anxiety	15	4.13	2.973	11	2.18	1.991	t(24)=1.88, p=0.07
	Psychological Distress	15	6.80	4.916	11	4.00	2.366	t(21.27)=1.92, p=0.07*
Week 10	Depression	15	2.40	1.805	13	1.92	2.100	t(26)=0.65, p=0.52
	Stress	15	1.87	1.767	13	1.77	2.166	t(26)=0.13, p=0.90
	Anxiety	15	5.53	2.748	13	4.00	3.317	t(26)=1.34, p=0.19
	Psychological Distress	15	9.80	4.916	13	7.69	7.064	t(26)=0.93, p=0.36

* Equal variances not assumed

4.9.8 Physical activity categories (Inactive/low active versus moderately active)

There were no significant differences in psychological distress between participants categorised as moderately active or inactive/low active at baseline, nor week 5 or week 10 (Table 4.16).

At week 5 and week 10 all participants assigned to group jogging condition demonstrated (non-significantly) lower psychological distress than those assigned to solo jogging conditions (Figure 4.10, Figure 4.11).

Table 4.16 Differences in Physical Activity Levels between Moderately and Inactive/Low Active Individuals between Group and Solo Jogging Conditions

Physical Activity Level			Solo Jogging Condition			Group Jogging Condition			Differences Between Conditions (Mann Whitney)
			N	Mean	SD	N	Mean	SD	
Moderate	Baseline	Depression	5	1.80	2.17	8	0.75	0.89	U=15.00, p=0.52
		Stress	5	2.00	2.55	8	0.63	0.92	U=13.50, p=0.35
		Anxiety	5	3.00	2.35	8	3.00	3.25	U=17.00, p=0.72
		Psychological Distress	5	6.80	6.94	8	4.38	3.81	U=15.50, p=0.52
	Week 5	Depression	5	1.20	1.79	7	1.29	0.95	U=14.00, p=0.64
		Stress	5	1.80	2.05	7	0.71	0.95	U=12.50, p=0.43
		Anxiety	5	4.00	1.87	7	2.00	1.91	U=6.00, p=0.07
		Psychological Distress	5	7.00	4.85	7	4.00	2.77	U=11.50, p=0.34
	Week 10	Depression	5	2.00	1.87	8	1.38	1.51	U=15.50, p=0.52
		Stress	5	2.20	1.48	8	1.38	1.19	U=13.00, p=0.35
		Anxiety	5	6.00	2.24	8	3.25	2.71	U=7.50, p=0.07
		Psychological Distress	5	10.20	4.09	8	6.00	4.66	U=10.50, p=0.17
Inactive/ Low	Baseline	Depression	10	0.60	1.90	5	0.60	0.89	U=18.50, p=0.44
		Stress	10	0.20	0.42	5	1.40	1.52	U=9.00, p=0.06
		Anxiety	10	3.70	3.40	5	4.80	1.64	U=19.50, p=0.51
		Psychological Distress	10	4.50	3.87	5	6.80	2.95	U=16.50, p=0.31
	Week 5	Depression	10	1.60	2.55	4	0.75	0.50	U=20.00, p>0.99
		Stress	10	0.90	1.37	4	0.75	0.96	U=19.50, p=0.95
		Anxiety	10	4.20	3.49	4	2.50	2.38	U=14.00, p=0.45
		Psychological Distress	10	6.70	5.21	4	4.00	1.83	U=14.00, p=0.45

	Week 10	Depression	10	2.60	1.84	5	2.80	2.77	U=25.00, p>0.99
		Stress	10	1.70	1.95	5	2.40	3.29	U=24.00, p=0.95
		Anxiety	10	5.30	3.06	5	5.20	4.15	U=22.50, p=0.77
		Psychological Distress	10	9.60	5.48	5	10.40	9.84	U=20.50, p=0.59

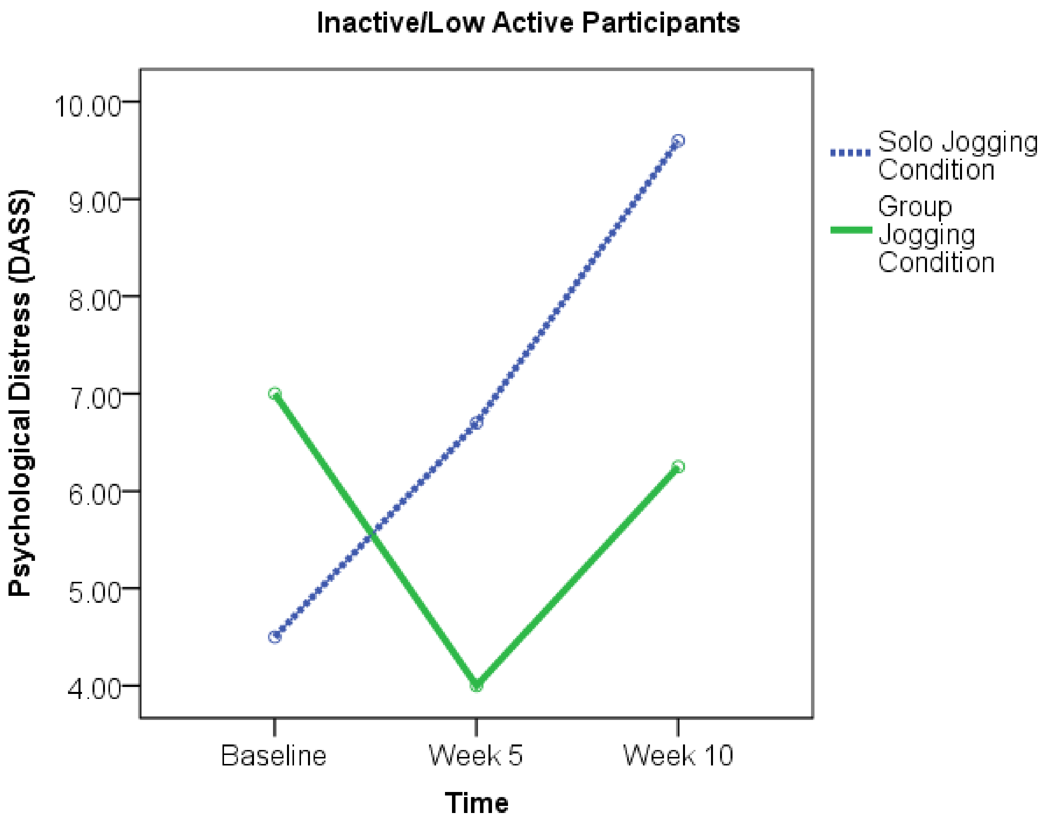

Figure 4.10 Psychological Distress of Group and Solo Jogging Conditions throughout Intervention Categorised as Inactive/Low Active

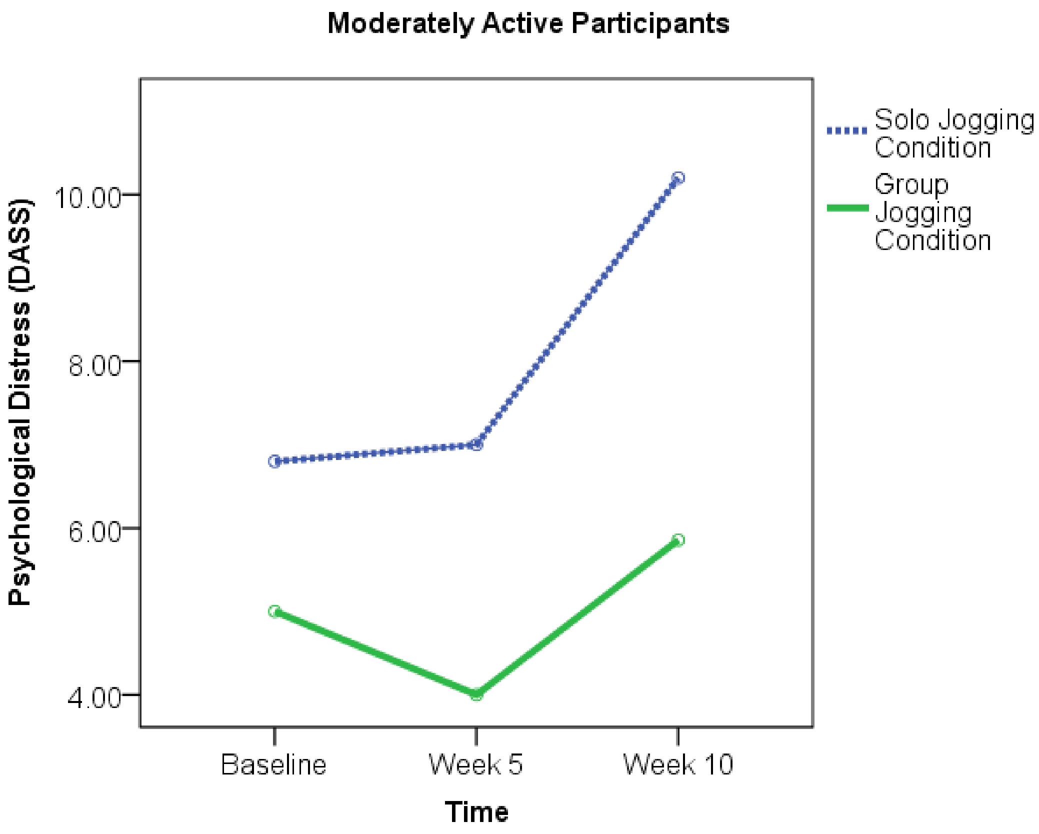

Figure 4.11 Group Versus Solo Jogging Condition of Inactive/Low Active Individuals' Psychological Distress

4.10 **Discussion**

The aim of this study was to investigate if participation in a jogging group led to greater engagement in jogging and physical activity and a greater reduction in psychological distress than jogging alone. The first hypothesis predicted that jogging in a group would result in greater jogging activity than jogging alone. All participants recorded the amount of jogging they engaged in, including any additional solo jogging for those assigned to the group condition. Participants from the group condition engaged in more jogging activity than the solo condition but not significantly, which was only due to additional supplementary solo jogging. When this additional solo jogging was excluded, the amount of jogging conducted by the solo condition was very slightly greater but non-significantly than that of the group jogging condition. This finding is in contrast by that of Burke, Carron, Eys, Ntoumanis and Estabrooks (2006), who found that adherence was significantly greater in standard exercise classes than home-based physical activity without contact. In the current study participants in both conditions were required to leave the home to complete the activity, thus incurring similar barriers. It is possible that a different activity (for example, the use of stationary bicycles) that can be conducted in the home versus an exercise facility may have resulted in a greater difference in activity between conditions.

The intervention was a beginner's jogging programme aimed at low or inactive individuals. However at baseline thirteen participants were identified as moderately active and fifteen as inactive or low. The inactive/low active individuals allocated to the group condition engaged in almost significantly more jogging overall than those allocated to the solo jogging condition, while jogging activity levels were almost identical between group and solo conditions for the moderately active. This suggests that the JogScotland beginners programme may be an effective intervention to promote physical activity to inactive or low active individuals, especially if they join a group.

The second hypothesis predicted that individuals allocated to the group condition would engage in more physical activity overall than those allocated to the solo physical activity condition excluding jogging activity. Physical activity was measured using the IPAQ at baseline, at week 5 and at week 10. There were no significant differences at baseline, but at week 5 and again at week 10 participants in the group condition engaged in significantly more moderate intensity activity than those in the solo condition despite no significant differences in jogging at week 5. This builds on findings by Casla et al. (2014) and Hunter, Wetzstein et al. (2000) who found significant improvement in physical activity outside of a group physical activity intervention, but did not compare a solo physical activity condition. Thus supporting the efficacy of group physical activity to promote physical activity beyond that specified by the intervention.

When inactive/low active and moderately active individuals were examined separately, the only significant difference between group and solo conditions was found at week five in inactive/low active participants. Those assigned to the group condition engaged in significantly more moderate activity than those assigned to solo. It was not possible to examine what specific activities participants were engaging in as the IPAQ is a general measure of physical activity. However differences did not persist to week 10, and if activities were leisure based these may have been discontinued due to increased academic demands such as the exam period and time or flexibility barriers for those in the group condition.

Throughout the intervention low or inactive participants from both conditions increased their physical activity levels. Moderately active participants assigned to the solo jogging condition appeared to maintain levels of physical activity from baseline to week 10, whereas physical activity levels decreased slightly for those assigned to the jogging group. While none of these changes were significant, it is possible that low or inactive individuals may have greater subjective scope to swap inactive activities with active ones compared with moderately active individuals.

Low or inactive individuals may have benefited more than moderately active participants, through greater improvements in subjective feelings of energy, which in turn may have influenced physical activity behaviour (King, Caudwell, Hopkins, Byrne, Colley, Hills, Stubbs & Blundell, 2007). Also, those from the group condition may have benefited from the increased motivation from encouragement from the group or leader to complete a session or not finish early. Increased self-efficacy may also contribute to physical activity which may be enhanced in group physical activity settings. Ashford, Edmonds and French (2010) found the most successful techniques to improve exercise self-efficacy include vicarious experiences (seeing others engage in the behaviour raises the individual's belief that they can also master that activity, Bandura, 1977) and the comparison of the individual's performance with the performance of others (Ashford et al., 2000). Ashford et al. (2010) found barrier identification and development of solutions was associated with lower self-efficacy. However self-efficacy may develop if the identification of barriers is used as a precursor to rehearsing what would be necessary to successfully change a behaviour rather than the reasons why an individual cannot perform the behaviour. This may be facilitated by a group leader or through advice from other members. However further research is required into student populations as only one study has investigated the differences in self-efficacy between group and solo physical activity conditions and found no significant differences at pre, post or follow-up for patients with arterial claudication (Pinto, Marcus, Patterson, Roberts, Colucci & Braun, 1997).

The final hypothesis predicted that those assigned to the group jogging condition would experience a greater reduction in psychological distress than those assigned to the solo. Psychological distress was measured at baseline, week 5 and week 10 and there were no significant differences between group and solo conditions at any of these points. Psychological distress increased significantly from baseline to week 10 for only those in the solo jogging condition, which does not support previous meta-analyses that exercise reduces depression and anxiety in healthy populations (Conn 2010a; Conn 2010b). However, participation in the group jogging condition may have protected against a similar increase in the psychological distress to that experienced by those in the solo condition. The distress may be related to academic demands as two data collection periods ran parallel to the university semester which concluded with an exam period. The third data collection period began in June 2009 and ended in August when master degree students were required to submit their thesis, which was another period of stress. Atousa (2009) conducted the only study to compare group and solo physical activity conditions in a student population and included a control group whose depression increased over a 10 week period during the semester. Therefore, this supports that the increase in psychological distress in the current study may be related to exam or thesis submission stress and anxiety, rather than as a result of the intervention. Atousa (2009) found group physical activity was significantly superior to solo in the reduction of depression. However participants in Atousa's (2009) study were selected for depression, whereas in the current study their psychological distress measures were very low. Atousa's (2009) participants may have had greater scope to reduce psychological distress than in the current sample. Further studies including a mildly distressed student population would benefit from the inclusion of a measure of mental well-being to examine increases in positive mood.

4.10.1 Strengths and limitations

This is the first study to compare the efficacy of a group versus solo jogging programme in the reduction of depression, anxiety and stress in a student population. Very few studies compare group versus solo physical activity in relation to stress and anxiety (Chapter 2), and although there was no significant difference between conditions, the findings from this study provide the impetus for investigating the protective effect of group versus solo physical activity on stress and anxiety on students.

This study measured physical activity outside of the intervention, which would have provided a control if regression analysis was used to evaluate the effects of the intervention on psychological distress, however the sample size was not large enough to power this statistical test. None of the studies in the systematic review (Chapter 2) included a measure of physical activity, and it may be problematic to assume that additional physical activity is being controlled without a measure even when participants have been requested to maintain physical activity levels from baseline throughout the intervention.

The physical activity prescription was well controlled between conditions as participants received the same JogScotland programme and both engaged in the same type of physical activity. Jogging was a valuable activity to use as participants were able to continue this behaviour after the study was completed as it was not dependent on facilities. Researcher bias was limited as participants were not supervised by the researcher. Contact with the researcher was equally limited between conditions as jogging diaries included a reminder at week 5 and week 10 to complete the online questionnaire including the web address.

Once participants started the intervention, none were lost to attrition which suggests that participants who began the programme were highly motivated. However the major limitation of this study was the low sample size, before the programme began 41.67% of individuals who agreed to participate dropped out. There were difficulties recruiting an adequate sample size to satisfy power calculations or to conduct regression analysis. This may be related to the commitment required to engage in a study over a ten week period, and also to engage in physical activity. Low active individuals were the target population, but 53.57% engaged in a moderate amount of physical activity at baseline which reflects the additional difficulty of recruiting inactive or low active individuals. The majority of participants in the current study were postgraduates as was the recruiter. This may reflect a greater willingness to take part due to the perceived similarity or familiarity with the recruiter. Further studies may benefit from a range of recruiters of the same sample population required for the study.

Participants who took part in the intervention had significantly lower measures of psychological distress than individuals who dropped out before the programme began. Although the drop outs had an average level of psychological distress for a student sample and for all individuals this was considered mild (Bayram & Bilgel, 2007). The low levels of psychological distress may have reduced the scope of improvement provided by the intervention. Future studies would benefit from examining individuals with higher levels of psychological distress, although this will incur further recruitment issues as they may be less responsive to advertisements to engage in research or activity, be unavailable or avoid social interaction with a recruiter. Future studies may also benefit from including a measure of positive well-being, as there may be greater scope to increase well-being than to reduce distress in a healthy population.

Jogging group leaders were provided with stickers for distribution to attendees to affix in their diaries, as an objective measure of attendance. However not all completed group jogging sessions included a sticker in the diary, and therefore was not a reliable method of verifying attendance. The stickers may have contributed as an incentive, or alternatively retaining these to stick in the diaries may have been a hindrance. Group attendance can be confirmed by others; consequently, reported adherence may be less influenced by demand characteristics. Therefore, it may be more important to objectively measure solitary physical activity. Further studies could utilise pedometers, or GPS tracking devices which could plot the route of the participant and time the session. However this may be considered overly invasive to participants.

4.10.2 Future studies

Future studies would benefit from sampling psychologically distressed students to assess improvements between group and solo physical activity conditions. This might be done by recruitment from GP practices, counselling services or mental health charities as physical activity promotion messages are more effective when delivered by a trusted source (Robertson, 2008). In addition further investigation would benefit from the inclusion of a measure of well-being as this may detect improvements in mood in non or mildly psychologically distressed populations. Future studies involving students would benefit from a non-exercise control group to monitor and control for fluctuations of well-being and psychological distress throughout the semester. Physical activity interventions would benefit from utilising technology to measure physical activity objectively using GPS and health tracking apps especially as 82% of UK university students own a smartphone (UCAS Media, 2013). Finally, further studies should investigate the influence of self-efficacy in group versus solo physical activities in students. This will be examined in the next study, which compares group and solo physical activity behaviour using an expanded model of the Theory of Planned Behaviour.

4.11 **Conclusion**

Approximately half of the participants recruited for this study were inactive or low active, and did not exhibit psychological distress and were likely to be highly motivated to engage in physical activity. However inactive individuals assigned to the group condition engaged in nearly significantly more jogging than those assigned to the solo, which suggests that a jogging group may be a more effective method of increasing physical activity than solo for low active individuals. Although differences in psychological distress were not significant between group and solo physical activity at all time points, those in the solo condition became more distressed throughout the intervention whereas those in the group condition did not. This may indicate a protective effect of group physical activity. Further research is required to confirm this and in addition detections of change in mood may benefit from the inclusion of a well-being measure in non-distressed populations.

Chapter 5

Comparing Group Versus Solo Physical Activity Using the Theory of Planned Behaviour

5.1 Introduction

Social cognitive theory provides a framework for understanding, predicting and changing behaviour (Callen, Braithwaite, & Westbrook, 2008). Human behaviour is identified as a reciprocal dynamic interaction between personal factors, behaviour and the environment (Bandura 1977; Bandura 1986; Callen, Braithwaite, & Westbrook, 2008). For example, the interaction between the individual and behaviour involves the influence of thoughts and actions while the interaction between the individual and environment involves beliefs and cognitive competencies that are adapted by social influences and structures within the environment (Olakanmi, Blake & Scanlon, 2011). Social cognitive theory has developed a number of social cognitive models such as the Theory of Planned Behaviour (Ajzen, 1988; 1991) to explain health related behaviour.

5.2 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB; Ajzen, 1985, Figure 5.1) proposes that behaviour is determined by an individual's intention to engage in that behaviour and their perceived behavioural control (PBC) over that behaviour. Intention to perform a behaviour is predicted by attitude, subjective norm and also perceived behavioural control. Attitudes are a function of beliefs about the perceived consequences of the behaviour. These beliefs are based on the perception of the resulting outcome from performing the behaviour, and the evaluation of that outcome (Conner & Sparks, 2005). Subjective norm is a function of normative beliefs representing perceptions of significant others' preferences on engagement in the behaviour and the pressure to comply (Ajzen, 1991; Conner & Sparks, 2005).

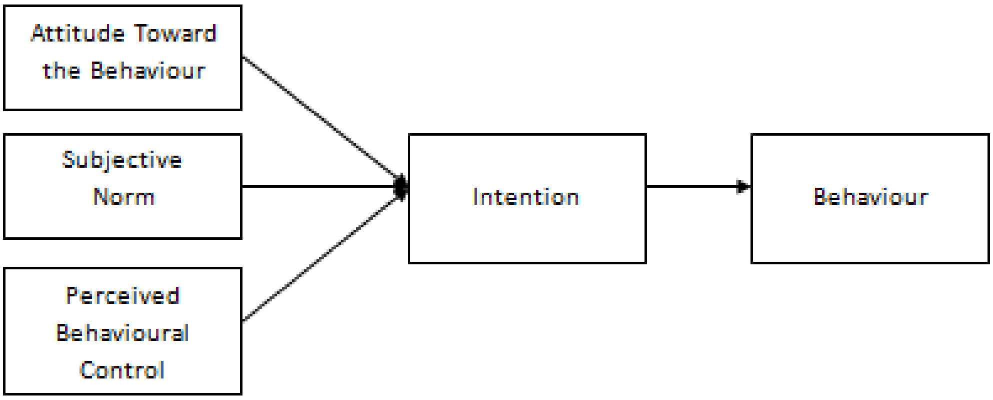

Figure 5.1 Theory of Planned Behaviour (Ajzen,2006)

More recently, Ajzen (2002a) proposes that each proximal antecedent of intention and behaviour should comprise of two specific components. He suggests that attitude should consist of an affective component which refers to the emotions provoked by the prospect of engaging in a behaviour and an instrumental component which relates to the cognitive appraisal of the extent to which a behaviour would be advantageous. Subjective norm should consist of an injunctive norms component which refers to the perception that important others want the individual to perform the behaviour, and a descriptive norms component which relates to whether or not important others engage in that behaviour (Ajzen, 2002b; Rhodes & Courneya, 2003). Ajzen (2002a) reports that injunctive norms often display low variability as important others tend to approve of desirable behaviour, and disapprove of undesirable behaviour. Therefore the addition of descriptive norms, which measures whether or not important others engage in the behaviour themselves, increases the variability of the subjective norm construct. Ajzen (2002a) suggests PBC should consist of controllability, which refers to the extent to which performing the behaviour is up to the individual, and self-efficacy which relates to the ease of difficulty of performing a behaviour and an individual’s confidence to perform it if they want to do so. An implication of the previous study was to consider the impact of self-efficacy in relation to group physical activity as it may be enhanced in group physical activity settings.

Within the field of physical activity research involving undergraduate university students (Rhodes & Courneya, 2003; Hagger & Chatzisarantis, 2005) these pairs of subcomponents have demonstrated discriminant validity, and represent discrete measures. The combined components of affective and instrumental attitude, injunctive and descriptive norm (Rhodes & Courneya, 2003; (Hagger & Chatzisarantis, 2005), controllability and self-efficacy (Hagger & Chatzisarantis, 2005) were found to act as general factors within the TPB model, supporting Ajzen's (2002a) recommendation that the TPB constructs should consist of the sum of these components. However Rhodes and Courneya (2003) found self-efficacy alone was the optimal predictor of intention, which does not support a combined PBC construct. Ajzen (2002b) argues that the regression of intention on these components, which are often strongly correlated, may result in multicolinearity effects. This would confound interpretations relating to the components or result in meaningless mediation effects, therefore recommends that these components be combined to represent the PBC construct.

Attitudes, subjective norm, and perceived behavioural control can be modified thus increasing an individual's intention to perform a desired behaviour, and the eventual likelihood of that behaviour (Francis, Eccles, Johnston, Walker, Grimshaw, Foy, Kaner, Smith & Bonetti, 2004). For example, an individual is more likely to perform physical activity if they are positively disposed toward it (attitude), if they perceive social pressure to do so (subjective norm), and if they believe they will be successful (PBC; Armitage, 2005).

5.3 **Theory of Planned Behaviour and Physical Activity**

The theory of planned behaviour has been applied extensively in the domain of physical activity and exercise (Hagger, Chatzisarantis & Biddle, 2002). Four meta-analyses have reviewed the efficacy of the TPB to predict both intention to engage in physical activity and actual physical activity behaviour (Blue, 1995; Godin & Kok, 1996; Hausenblas, Carron & Mack, 1997; Hagger, Chatzisarantis & Biddle, 2002).

Blue (1995) reviewed 16 studies using the models defined by the Theory of Reasoned Action (TRA, Fishbein & Ajzen, 1975; Ajzen, Fishbein, & Heilbroner,

1980) and seven using the TPB model to investigate physical activity. The TRA was the precursor to the TPB and does not incorporate the PBC component. Participant samples were diverse and included healthy young and middle aged adults, pregnant women, individuals with disability and individuals with heart disease. Godin and Kok (1996) reviewed 18 studies addressing physical activity with the TPB only, including all seven TPB studies featured in Blue's (1995) analysis. The additional 11 study samples were similar in diversity as found in Blue's (1995) review.

Hausenblas, Carron and Mack (1997) reviewed studies utilising the TRA or the TPB to investigate physical activity and included 31 studies. Their sample excluded children but included clinical and non-clinical samples of adolescents, adults and older adults. The review included more university students (50% of total review participants) than previous analyses. Hausenblas, Carron and Mack (1997) reported TRA/TPB construct correlations but did not report the amount of variance explained by the TRA/TPB models (Table 5.1). The remaining meta-analyses report that the TPB accounts for similar variances of intention to engage in physical activity (an overall average of 43.4%). However, the explained variance of physical activity behaviour was somewhat dissimilar between reviews (resulting in an overall average of 32.5%). These outcomes are slightly better than the averages found by Armitage and Conner (2001) who reviewed a variety of health behaviours including 185 studies, and found 39% of the variance of intention and 27% of behaviour was explained by the TPB.

A more recent meta-analysis from Hagger, Chatzisarantis and Biddle (2002) reviewed the TRA and TPB and evaluated the inclusion of past behaviour and self-efficacy as additional constructs to explain physical activity. The meta-analysis included 72 studies (including 79 samples) representing a diverse range of individuals, the greatest number of studies included samples of healthy adults (27.85%), followed by children (25.32%), university students (22.78%), clinical patients (12.66%), the remaining samples included healthy adults recruited from exercise classes and health clubs (8.86%) and pregnant and post-natal women (2.53%).

Table 5.1 Average Accounted Mean Variance of Intention to Engage in and Physical Activity Behaviour from TPB Models

Explained Variance (%)	Blue (1995)*	Godin & Kok (1996)	Hausenblas, Carron & Mack (1997)	Hagger, chatzisarantis & Biddle (2002)*
Intention	43.4	42.4	Not reported	44.5
Behaviour	33.8	36.3	Not reported	27.4

* Including only TPB model outcomes

Intention to engage in physical activity was most strongly correlated with attitude, followed by PBC and subjective norm in Blue (1995), Godin and Kok (1996), Hausenblas, Carron and Mack (1997) and Hagger, Chatzisarantis and Biddle's (2002) meta-analyses (Table 5.2). Likewise, in all reviews, there were stronger correlations between physical activity behaviour and intention than behaviour and PBC. The relationship between intention and attitude, subjective norm and behaviour was conceptually identical between TRA and TPB models, thus all correlations were included below (Table 5.2).

Table 5.2 Average Correlations and Regression Coefficients of Intention to Engage in and Physical Activity Behaviour with TPB and TRA Constructs

		Blue (1995)	Godin & Kok (1996)	Hausenblas, Carron & Mack (1997)	Hagger, Chatzisarantis & Biddle (2002)	Mean Average
Correlation (r)						
Intention	Attitude	0.51	0.51	0.52	0.48	0.51
	Subjective Norm	0.33	0.30	0.27	0.25	0.29
	PBC	0.46	0.50	0.43	0.44	0.46
Behaviour	Intention	0.46	0.52	0.47	0.42	0.47
	PBC	0.42	0.41	0.45	0.31	0.40
Regression Coefficient (β)						
Intention	Attitude	Not reported	0.29	0.40	Not reported	0.35
	Subjective Norm	Not reported	0.11	0.05	Not reported	0.08
	PBC	Not reported	0.33	0.33	Not reported	0.33
Behaviour	Intention	Not reported	0.40	0.42	Not reported	0.41
	PBC	Not reported	0.31	0.15	Not reported	0.23

Two meta-analyses reported regression coefficients of TPB constructs on intention and behaviour (Godin & Kok, 1996; Hagger, Chatzisarantis & Biddle, 2002; Table

5.2). Both reviews found subjective norm contributed the least to intention. However, Godin and Kok (1996) found PBC was a greater contributor to intention than attitude while Hagger, Chatzisarantis and Biddle (2002) found the converse. Both reviews found intention was a greater contributor to physical activity behaviour than PBC.

A limitation of these meta-analyses is the inclusion of studies featuring different types of physical activity, without differentiation to context, such as group or solo physical activity, therefore it is not possible to form conclusions on the differences or similarities of group and solo physical activity using the TPB. Eves, Hoppéa and McLaren (2003) compared six types of physical activities including team sports and aerobics (as examples of vigorous intensity leisure-time pursuits), dancing and swimming (examples of moderate intensity leisure-time activities) and walking and cycling (examples of low intensity lifestyle physical activities). However, they were not explicit as to whether or not these activities were performed with others or alone, and it was not their intention to compare group and solo. Team sports and dancing usually involves others and could be considered as group physical activity. The authors reported that swimming probably involved others as subjective norm significantly contributed to intentions, however it may be possible to influence an individual's intention to go swimming without also engaging in the behaviour, therefore it is not possible to assume that swimming in Eves et al.'s (2003) study included the presence of others during the behaviour. Subjective norm did not make a significant contribution to intention to engage in those specific physical activities (Table 5.4).

Eves, Hoppéa and McLaren (2003) found the TPB accounted for an overall average of 40.31% of the variance of intention to engage in the activities. Intention to engage in team sports was best explained by the TPB, accounting for 55.8% of the variance, followed by dancing (55.2%), swimming (48.1%), aerobics (36.9%), cycling (28.4%) and walking (17.5%). The TPB accounted for an overall average of 39.17% of the variance of physical activity behaviours. Swimming was best explained by the TPB, account for 47.3% of the variance followed by cycling (45.5%), team sports (43.7%), aerobics (42.5%), dancing (31.4%) and walking (24.6%). The average explained variance of behaviours was greater than Hagger, Chatzisarantis and Biddle's (2002) findings of 27.4%, indicating that there is variation between different physical activities.

Correlations of attitude and intention may be potentially stronger for group-based activities than solo. Team sports and dancing reported stronger correlations of affective and instrumental attitude with intention than cycling (which may be been a solitary activity) and with the meta-analysis derived average (Table5.3). Likewise, for team sports and dancing there were stronger correlations between intention and PBC, and behaviour and PBC than the other activities and the meta-analysis average. However, the correlations between intention and behaviour were of similar strength throughout activities and were all greater than the meta-analysis average. The comparative strength of correlation may be due to the specification of activities, rather generic terms of "exercise" or "physical activity".

Table5.3 TPB Components Correlations with Intention to Engage in and Physical Activity Behaviour from Eves, Hoppéa and McLaren (2003)

Correlations (r)	Intention				Behaviour	
	Affective Attitude	Instrumental Attitude	Subjective Norm	PBC	PBC	Intention
Team Sports	0.68**	0.56**	0.54**	0.65**	0.47**	0.68**
Aerobics	0.60**	0.40**	0.45**	0.41**	0.31**	0.65**
Swimming	0.67**	0.37**	0.50**	0.35**	0.23**	0.69**
Dancing	0.70**	0.58**	0.57**	0.65**	0.41**	0.57**
Cycling	0.45**	0.30**	0.31**	0.46**	0.27**	0.68**
Walking	0.21**	0.18*	0.22**	0.41**	0.17	0.51**
Meta-Analysis Mean Average#	Attitude: 0.51		0.29	0.46	0.40	0.47

**p<0.001; *p<0.01; # Including Blue (1995), Godin and Kok (1996), Hausenblas, Carron and Mack (1997), Hagger, Chatzisarantis and Biddle (2002) but excluding Eves, Hoppéa and McLaren (2003)

Affective attitudes contributed significantly to intention to engage in physical activity for nearly all types of activities (excluding walking, Table 5.4), whereas instrumental attitudes did not contribute significantly to intention for any of the activities. Subjective norm made a significant contribution to intention for swimming alone, while PBC contributed significantly to intention in all the activities. PBC did not contribute significantly to behaviour in any of the activities, however intention did contribute significantly in all. It is possible that PBC did not contribute significantly to behaviour as participants were already engaging in physical activity as Eves et al. (2003) recruited participants using a cross-sectional design with no requirement of stage of physical activity engagement.

For team sports and swimming, affective attitude was the greatest predictor of intention to engage in those activities, closely followed by PBC. For cycling, which may have been a solo activity, PBC was found to be a greater contributor to intention than affective attitude. Thus it is possible that TPB components contribute differently to the intention to engage in physical activity depending on group or solo contexts. There was a greater contribution between intention and behaviour for cycling than team sports and dancing, which may imply that intention is less important in predicting social physical activity. However, the social contexts of these activities can only be speculated. A better comparison would include an identical physical activity that could be conducted alone or in a group, such as jogging. Further investigation is required to confirm potential differences between group and solo physical activity and the TPB.

Table 5.4 Regression Coefficients of TPB Components Contribution to Intentions to Engage in and Physical Activities Performance from Eves, Hoppéa and McLaren (2003)

Regression Coefficients (β)	Intention				Behaviour	
	Affective Attitude	Instrumental Attitude	Subjective Norm	PBC	PBC	Intention
Team Sports	0.48**	-0.08	0.07	0.38**	0.05	0.64**
Aerobics	0.51**	0.07	0.10	0.15*	0.09	0.63**
Swimming	0.59**	-0.08	0.17**	0.12*	-0.03	0.70**
Dancing	0.42**	0.02	0.12	0.29**	0.10	0.50**
Cycling	0.30**	0.03	0.02	0.33**	-0.04	0.70**
Walking	0.06	-0.01	0.12	0.37**	-0.05	0.53**
Meta-Analysis Average#	Attitude: 0.35		0.08	0.33	0.23	0.41

Including & Kok (1996) and Hagger, Chatzisarantis & Biddle (2002)
** p<0.001
*p<0.05

5.4 **Extending the Theory of Planned Behaviour**

Conner and Armitage (1998) suggest the TPB constructs are not sufficient to fully explain an individual's intention and behaviour. Ajzen (1991, 2011) supports the addition of components to the TPB, stating the model is open to further elaboration. Therefore, more recent research has attempted to identify additional constructs that may improve explained variance of intention and behaviour.

Chatzisarantis, Hagger and Brickell (2008) suggests that the subjective norm construct only represents a pressuring form of social influence, which tends to suppress motivation rather than enhance it (Brehm & Brehm, 1981; Ryan & Deci, 2000). To further understand the effect of motivation from others, Chatzisarantis, Hagger and Brickell (2008) recommend the inclusion of a component which represents a non-pressuring form of social influence, which is more likely to enhance motivation (Brehm & Brehm, 1981; Ryan & Deci, 2000). The perceived autonomy support (PAS) measure developed by Chatzisarantis, Hagger and Brickell (2008) relates to self-determination theory (Deci & Ryan, 1985) and represents the degree to which significant others encourage choice, understand these choices, convey confidence in another's ability and acknowledge other's feelings and perspectives in relation to physical activity.

PAS and subjective norm were found to be discrete components and inclusion of PAS to the TPB model increased the explained variance of physical activity behaviour from 32% to 35% (Chatzisarantis, Hagger & Brickell, 2008). PAS was found to significantly, indirectly effect physical activity behaviour through attitudes ($\beta=0.08$, $p<0.05$) and intention ($\beta=0.15$, $p<0.05$). There was a stronger correlation between intention to engage in physical activity and PAS ($r=0.38$, $p<0.05$) than intention and subjective norm ($r=0.11$, $p<0.05$). Likewise there was a stronger correlation with physical activity behaviour and PAS ($r=0.34$, $p<0.05$) than with physical activity behaviour and subjective norm ($r=0.11$, $p>0.05$). The inclusion of PAS may have provided Eves, Hoppéa and McLaren (2003) further information relating to the social effects within the models. For example, if team sports and dancing were recreational and not competitive there may not have been social pressure to engage in those activities. However there may have been encouragement from their peer group which may not have been captured by the subjective norm construct.

5.5 Aims

Eves, Hoppéa and McLaren (2003) found the TPB accounted for greater variance to engage in team sports and dancing compared to other activities which may have been less social. Therefore, the current study investigated if the variance predicted using the TPB (as outlined by Ajzen 2002a, including two components summed to represent the proximal antecedents of intention and behaviour) was greater for group physical activity than solo physical activity. The current study also compared differences in contributions of TPB antecedents of intention and behaviour between group and solo physical activity. Finally the current study expanded the TPB model to include PAS (as defined by Chatzisarantis et al., 2008) and compared the change in predicted variance of group and solo physical activity, before it compared the contribution of PAS between group and solo physical activity models.

5.5.1 Research Question

Using the Theory of Planned Behaviour to explain group and solo physical activity in a student population, are there different factors involved in predicting group and solo physical activity?

5.6 Methods

5.6.1 Ethical issues

This project was granted ethical approval by the School of Health in Social Science, University of Edinburgh (Appendix D). Participants completed two questionnaire packs online (Appendix B11 and Appendix B12). The questionnaires which were hosted by Surveymonkey.co.uk, were password protected and only accessible by the researcher. Responses were downloaded in Microsoft Excel format and converted into a password protected SPSS data file.

Consent forms were not included in the questionnaire pack, as consent was assumed if individuals chose to complete the online questionnaires. This was intended to help protect anonymity as participants were not required to give their name. However they were asked to provide an email address as email addresses were used to match responses from the first questionnaire packs with the second, award a gift voucher from the prize draw and inform participants of the results of the study. Respondents were provided with a unique identification code ensuring participants could not be identified or associated with their responses. A separate file containing email addresses and identification codes was deleted once questionnaires had been matched, in accordance with the Data Protection Act (1998).

There were two data collection periods; each period included a £50 Amazon.co.uk prize draw to incentivise participation. Amazon.co.uk was chosen to reduce potential response bias as it offers a wide range of products which should generally appeal to most university students. A separate list of email addresses of participants who indicated that they wanted to be entered into the prize draw were kept until the prize draw was drawn. The winner was picked by a member of staff from the Department of Clinical Psychology who was unconnected to the study and subsequently emailed with the Amazon.co.uk gift voucher. In accordance with the Data Protection Act (1998), this personal information was deleted on confirmation of gift voucher acceptance from the winner.

A separate file contained a list of email addresses representing the individuals who requested a summary of the study findings. No further identifying information was stored in this file. This file was deleted when study findings were sent (conforming with the Data Protection Act, 1998).

The Data Protection Act (1998) requires personal information to be held for no longer than is necessary and then deleted. As email addresses were not associated with the research data it therefore contained no personal information, the data is defined as unidentifiable research data and is considered as not covered by the Data

Protection Act (1998). The Scottish Executive Research Governance Framework (2006) recommends that "data collected in the course of health research must be retained for an appropriate period to allow further analyses by the original or other research teams subject to consent and to support monitoring by regulatory and other authorities". This unidentifiable research data will be uploaded to the University of Edinburgh Data Repository in addition to the doctoral thesis.

5.7 Participant Recruitment

Eligible participants were undergraduate and postgraduate university students of Edinburgh universities. Included universities were University of Edinburgh, Napier University, Heriot-Watt University and Queen Margaret University. Participants were required to be older than 18, with no upper age limit. Responses were excluded if respondents indicated that they were not a student or completed less than 10% of the questionnaire (Tabachnick & Fidell, 2001).

Participants self-identified in response to advertisements. Leaflets (Appendix E5) were distributed throughout university areas. Posters (Appendix E6) were displayed in communal student areas. An advertisement was placed on social media tool "Facebook.com" which was accessible to students from Edinburgh universities only. All advertisements contained a web address which directed potential participants to a welcome webpage, and included details of the gift voucher incentive. The webpage invited respondents to participate in the study and download a participant information sheet (Appendix B10). They could then choose to complete the online questionnaire.

5.7.1 Procedure

Participants completed a questionnaire pack addressing the components from the Theory of Planned Behaviour (TPB). This included measures of attitude, subjective norm, perceived autonomy support (PAS), perceived behavioural control (PBC) and intention to perform physical activity. This model was measured in relation to four forms of physical activity: general group physical activity, general solo physical activity, jogging in a group and jogging alone. This resulted in a set of four questionnaires compiled into a single pack.

The questionnaire sets were counterbalanced to reduce potential order effects. To reduce any potential priming effects, questionnaire sets relating to jogging were presented after group and solo physical activity questionnaires. Due to this constraint, there were four different orders of questionnaire sets (Table 5.5). Four separate online questionnaires were created representing each order of sets, and hosted online using surveymonkey.co.uk. The online questionnaire packs were identical except for the order of questionnaire sets.

When participants visited the advertised web address (juliesresearch.co.uk), it automatically randomly redirected participants to one of the four versions of the questionnaire. This was achieved using a custom web based script.

Table 5.5 Four Versions of TPB Questionnaire Pack Order

Orders	Physical Activity Type
Order 1	General Group Activity General Solo Activity Group Jogging Solo Jogging
Order 2	General Solo Activity General Group Activity Solo Jogging Group Jogging
Order 3	General Group Activity General Solo Activity Solo Jogging Group Jogging
Order 4	General Solo Activity General Group Activity Group Jogging Solo Jogging

Participants completed two questionnaire packs, the second 2 weeks following the first. To encourage participation, an incentive was provided. On completion of both questionnaires, participants were eligible to be entered into a prize draw to win a £50 Amazon.co.uk gift voucher.

Respondents were given the opportunity to provide their email address in order to be entered into the prize draw, to receive a summary of the study's findings, to be invited to complete the second questionnaire, and to be identified through the two parts of analysis. Once identification was conducted, participants were assigned a unique ID code, which was used in analysis to ensure anonymity. Current and valid email addresses were obtained as respondents were reminded that if they won the prize draw, the Amazon.co.uk gift voucher would be emailed to the email address supplied. In addition, on emailing the details of the second questionnaire pack, none of the email addresses resulted in a "non-delivery report", indicating their validity.

The completion date of the first questionnaire was recorded with responses. Exactly two weeks after their completion of the first pack, participants were emailed and invited to complete the second online questionnaire pack. This questionnaire pack addressed the final TPB component, behaviour, which measured group and solo jogging and group and solo physical activity performed over the previous two weeks. The pack contained a single questionnaire; a researcher designed Participation in Group and Solo Jogging and Group and Solo Activity Questionnaire and a single item asking participants to leave their email address in order to be matched with the previous questionnaire, check box to indicate that they wished to be entered into the prize draw, and a check box to indicate that they wished to receive a copy of the study's findings.

5.7.2 Participants

Power calculations required at least 82 participants for multiple regression analysis including 4 independent variables (Green, 1991). Sivo, Fan, Witta, and Willse (2006) report that there is little consensus on recommended sample size requirements for Structural Equation Modelling (SEM) methodology. One widely published method is the "rule of ten", which recommends sample sizes of at least 10 times as many individuals as variables (Nunnally, 1967). Westland (2010) criticises this "rule of ten", claiming Nunnally (1967) offered no supporting evidence and recommends that sample size should derive from the ratio of indicators to latent variables (Marsh & Bailey; Boomsma, 1982) rather than the number of indicators, as suggested by the rule of 10. For example, Boomsma (1982) demonstrates that a ratio of indicators to latent variables of 4 would require a sample size of at least 100 and 2 would require a sample of at least 400. Marsh et al. (1988, 1996, 1998) suggest a ratio of 3 would require a sample size of at least 200 and 12 would require a sample size of at least 50. Westland (2010) indicates these findings can be expressed below, where r is expressed as the ratio of indicators to latent variables:

$$n \geq 50r^2 - 450r + 1100$$

The lowest ratio of latent variables to indicators (including Intention, Attitude, Subjective Norms, Perceived Autonomous Support and Perceived Behavioural

Control expanded to represent Controllability and Self-Efficacy) was 6:26, indicating a sample of at least N=100 for analysis.

The first period of data collection resulted in 78 completed responses to the first questionnaire pack. Therefore, further data were collected over a second time period to satisfy sample size and power requirements for both multiple regression analysis and SEM.

The first period of data collection resulted in 78 completed responses to the first questionnaire pack. Therefore, further data were collected over a second time period to satisfy sample size and power requirements for both multiple regression analysis and SEM. The first set of data was collected in March 2010 which included 104 responses. Twenty-six responses were excluded as less than 10% of the questionnaire was completed, resulting in 78 acceptable responses to the first questionnaire pack. 59 participants completed the second questionnaire pack 2 weeks later. The second set of data was collected in April 2011, which included 171 responses. Thirty-three responses were excluded due to poor completion rates, 2 for indicating non-student status, concluding with 136 acceptable responses. A further 66 participants completed the second questionnaire pack 2 weeks after the first pack. Overall, this resulted in a total of 214 responses to the first part questionnaire pack, and 125 to the second questionnaire pack.

A t-test indicated no significant differences in age between Dataset 1 ($M=27.76$, $SD=7.44$) and Dataset 2 ($M=27.42$, $SD=6.50$), $t(211)=0.34$, $p=0.73$. Chi-Square tests indicated no significant differences in sex, the university of the respondent or university course (Table5.6) between datasets. However, there was a significant difference in relationship status between dataset 1 and 2. Both datasets were combined (Table5.7) to create one dataset for further analysis.

Table5.6 Frequencies and Differences between Datasets

	Dataset 1 (March 2010)		Dataset 2 (April 2011)		Difference Between Samples
	N	%	N	%	
Sex					
Male	27	34.6	48	35.3	χ^2(1, N=214) = 0.01, p=0.92
Female	51	65.4	88	64.7	
Total	78	100.0	136	100.0	
Relationship					
Single	28	35.9	43	31.6	
In A Relationship	31	39.7	32	23.5	χ^2(3, N=214) = 18.09, p<0.01
Co-habiting/Married	16	20.5	61	44.9	
Declined To Answer	3	3.8	0	0.0	
Total	78	100.0	136	100.0	
University Level					
Undergraduate	33	42.3	51	37.5	χ^2(3, N=214) =1.03, p=0.80
Postgraduate	45	57.7	85	62.5	
Total	78	100.0	136	100.0	
University					
University of Edinburgh	54	69.2	85	62.5	
Heriot-Watt University	9	11.5	18	13.2	
Napier University	14	17.9	31	22.8	χ^2(1, N=214) =0.48, p=0.49
Queen Margaret University	1	1.3	2	1.5	
Total	78	100.0	136	100.0	

Table5.7 Demographics of Combined Datasets

Demographic Variable		N	%	Mean	SD
Age		213	99.53	27.54	6.85
	Declined To Answer	1	0.47		
	Total	214	100		
Sex	Male	75	35.0		
	Female	139	65.0		
	Total	214	100.0		
Relationship	Single	71	33.2		
	In A Relationship	63	29.4		
	Co-habiting/Married	77	36.0		
	Declined To Answer	3	1.4		
	Total	214	100.0		
University	University of Edinburgh	139	65.0		
	Heriot-Watt University	27	12.6		
	Napier University	45	21.0		
	Queen Margaret University	3	1.4		
	Total	214	100.0		
University Course	Undergraduate	84	39.3		
	Postgraduate	130	60.7		
	Total	214	100.0		

5.7.3 Measures

Participants completed two questionnaire packs. The first pack consisted of a demographic measure and four sets of questionnaires addressing the Theory of Planned Behaviour (TPB). Participants were asked to complete each set in relation to each form of physical activity: general group physical activity, general solo physical activity, jogging in a group and jogging alone.

Each questionnaire set contained 5 measures addressing the components of the TPB (Appendix B11). This included measures of attitude, subjective norm, perceived autonomy support (PAS), perceived behavioural control (PBC) and intention to perform physical activity. This resulted in 26 items per set, and 104 items in total.

The second questionnaire pack (Appendix B12), received 2 weeks after completion of the first questionnaire, measured group and solo jogging and physical activity and included 21 items. If participants did not engage in a particular form of activity they could skip all questions relating to it, reducing the time required to complete the questionnaire.

The first questionnaire pack included the following measures:

a) Demographic Questionnaire

This comprised eight items to gather information on age, sex, marital status, children, university, and university course.

b) Attitude

Attitude is defined as the overall evaluations of performing behaviour (Rhodes & Courneya, 2003). Attitude was comprised of two subcomponents, affective (e.g. enjoyable/unenjoyable) and instrumental (e.g. beneficial/harmful) evaluations toward a behaviour. Both components consisted of 3 items each and were measured using seven-point bipolar adjective scales (Ajzen, 2002). The Instrumental Attitude component was measured using the following dichotomies: useful–useless, wise–foolish, and beneficial–harmful, while the Affective Attitude component included: enjoyable–unenjoyable, interesting–boring, relaxing–stressful. Participants responded to the following statement (per each physical activity type) which preceded the six dichotomies, "For me, participating in [type of physical activity] regularly over the next 2 weeks would be…"Rhodes and Courneya (2005) demonstrate acceptable psychometrics of these subcomponents in physical activity with an undergraduate population (n=585). Internal consistency for instrumental attitude (α=0.80) and affective attitude (α=0.74) were both acceptable (Rhodes & Courneya, 2005).

c) Subjective Norm

Subjective norm is defined as the perceived social pressure to perform behaviour. Subjective norm is comprised of two subcomponents, injunctive (perception that important others approve of the behaviour) and descriptive norms (perception that important others participate in the behaviour, Ajzen, 2000). Injunctive norm was determined using two items on a seven-point Likert scale ranging from "strongly agree" to "strongly disagree". These items were: "Most people in my social network want me to take part in regular [type of physical activity] in the next two weeks" and "Most people in my social network would approve if I took part in regular [type of physical activity] in the next two weeks."Descriptive norm was determined using three items on a seven-point Likert scale also ranging from "strongly agree" to "strongly disagree". These items were: "Most of my friends take part in regular [type of physical activity]", "Most of my family members take part in regular [type of physical activity]", "Most of my co-workers take part in regular [type of physical activity]". These items were originally developed by Courneya, Bobick and Schnick (1999), based on the important social referents of exercise behaviour from Sallis, Grossman, Pinski, Patterson, and Nader (1987). Rhodes and Courneya (2005) report that previous exercise research involving undergraduate students provided acceptable reliability for this component (α=0.91, Courneya et al., 1999).

d) Perceived Behavioural Control

Perceived behavioural control has been defined as the perceived ease or difficulty of performing behaviour (Ajzen, 1991). PBC consisted of two subcomponents self-efficacy and controllability (Ajzen, 2002). Self-efficacy is defined as confidence in one's own ability to perform behaviour. Controllability is one's perceived control over behaviour (Armitage & Conner, 1999a, 1999b). Both components consisted of three-items each and were measured using seven-point Likert scales. The self-efficacy component ranged from very unconfident to very confident. For example, "How confident are you that you will be able to participate in [type of physical activity] regularly in the next 2 weeks?" The controllability component ranged very little control to complete control. For example, "How much personal control do you feel you have over participating in [physical activity] regularly in the next 2 weeks?' Both self-efficacy and controllability items were adapted by Rhodes and Courneya (2003) for physical activity research from Armitage & Conner (1999a, 1999b) and Armitage et al. (1999) who identified acceptable psychometrics (α=.81, Courneya 1999).

e) Perceived Autonomous Support

Perceived autonomy support was defined as participants' perceptions about whether significant others (e.g., friends, family members, etc.) provide choice and rationale about physical activity, acknowledge personal evaluations and express confidence in ability to take part in physical activity (Chatzisarantis, Hagger & Brikell, 2008). Chatzisarantis et. al. (2008) recommended the inclusion of this component to complement subjective norms, providing a measure of both pressuring and non-pressuring forms of social influence. The perceived autonomy support scale consisted of six items using a seven-point Likert scale ranging from "strongly agree" to "strongly disagree". Significant others were defined to participants as the people who were important to them (e.g., friends, family members, etc.). An example item, "Significant others provide me with choice and options to participate in [physical activity]". The measure was adapted from the Health Care Climate questionnaire (Williams, Grow, Freedman, Ryan, & Deci, 1996) and validated by Chatzisarantis, Hagger & Smith (2007) who reported acceptable psychometrics using university students and young adults (α=.86).

f) Intention to Perform Physical Activity

Behavioural intention is an individual's readiness to perform a given behaviour and considered to be the immediate antecedent of behaviour (Ajzen, 2002). Intention was assessed by three items (Rhodes & Courneya, 2003). The first, "In the next 2 weeks, my goal is to participate in [type of physical activity]" was rated on a seven point Likert scale ranging from "not at all" to "every day". The second item "Over the next two weeks, I intend to participate in [type of physical activity] __ times per week" rated on an open scale (Courneya, 1994). The third item "I intend to participate in [type of physical activity] at least every other day over the next two weeks", rated on a seven point Likert scale ranging from "strongly disagree" to "strongly agree". These items demonstrated acceptable psychometrics in previous research relating to physical activity and undergraduate students (α=0.81, Courneya 1999).

The second questionnaire pack included the following measure:

g) Behaviour - Participation in Group and Solo Jogging and Group and Solo Activity

Participants were required to record the frequency and duration of group jogging in the past seven days, and provide the same details for jogging alone. The quantity of jogging was calculated using frequency x duration x intensity. Intensity was defined as 7 METs (Ainsworth et al.,2002).

Respondents were then asked to detail all their physical activities performed in groups and alone. Respondents specified every activity they engaged in, frequency and duration. Specific physical activity intensities were identified using Ainsworth et al.'s (2002) compendium of physical activities in terms of MET scores. Quantity of physical activity was defined as intensity of physical activity x duration x frequency. If multiple activities were noted, these scores were combined.

5.7.4 Data analysis

Structural equation modelling (SEM) was used to evaluate the theory of planned behaviour. This was preferable to multiple regression which would have required two regression analyses to evaluate the model. The first would examine the influence of attitudes, norms, PAS and PBC on intention. A second would then be required to assess the influence of intention and PBC on behaviour. SEM eliminates the necessity of two separate analyses, and allows the whole TPB model to be assessed in one analysis because SEM can incorporate multiple independent and dependent variables (Savalei & Bentler, 2006). As multiple regression analysis is not capable of modelling variables which may be both independent and dependent (as intention is when predicting behaviour), SEM was utilised to complete the analysis.

All analyses were conducted using IBM SPSS Statistics version 20.0.0 (2011) and STATA SE13 (2013). Missing data were treated using Maximum Likelihood (ML) estimation which was employed for all analysis. Maximum Likelihood (ML) is the most widely used fitting function for SEM (Schermelleh-Engel, Moosbrugger & Müller, 2003) and requires a degree of multivariate normality. However, Hankins (2008) reports that ML is quite robust and is acceptable when the sample size is between 200-500 and the distribution is not overly non-normal (univariate skewness < 2 and univariate kurtosis <7, West et al., 1995). The goodness of model fit was assessed using a range of statistics following guidelines in Kline (2005) and Schumacker and Lomax (2004). Goodness of fit index (GFI) is not recommended for assessment as it is overly influenced by sample size (Sharma, Mukherjee, Kumar & Dillon, 2005). Root mean square error of approximation (RMSEA) and comparative fit index (CFI) are recommended as they are less sensitive to sample size (Fan, Thompson, & Wang, 1999). A non-significant chi-square and comparative fit index (CFI) above 0.95 (Hu & Bentler, 1999) are considered acceptable. Values of root mean square error of approximation (RMSEA) less than 0.01 indicate an excellent fit, 0.05 good and 0.08 mediocre fit (MacCallum, Browne & Sugawara, 1996).

The first hypothesis predicts that the original TPB model (Ajzen, 2001, Figure 5.1) will better explain group physical activity intention and behaviour than solo by comparing the variance explained by the models. The second hypothesis predicts that the differences in contributions of TPB antecedents of intention and behaviour will be different between group and solo physical activity. This will be conducted using Wald's test of group invariance for parameters to investigate differences in paths of TPB constructs between group and solo physical models. The third hypothesis predicts that the TPB model will better explain group and solo physical activity when augmented by Perceived Autonomous Support (PAS) as specified by Chatzisarantis, Hagger and Brickell (2006), with PAS contributing to attitudes, intention and physical activity.

Originally, the previous hypotheses were formulated to evaluate group and solo physical activity and group and solo jogging using SEM methodology. However, both measures of group and solo jogging activity violated the assumptions of SEM and Multiple Regression. The number of respondents engaging in jogging activity was not adequate for SEM or Multiple Regression analysis (solo jogging N=30, group jogging N=10), therefore these results were excluded from further analysis.

5.8 **Results**

Table 5.8 demonstrates the means and standard deviations of TPB (Theory of Planned Behaviour) components and subcomponents. T-tests indicated significant differences between all group and solo physical activity components except for affective attitude; in each case the mean for solo was greater than for group. This indicates that respondents demonstrated more negative attitudes, subjective norms (including subcomponents), less perceived autonomy support and perceived behavioural control (including subcomponents) towards solo physical activity. However, respondents indicated greater intentions to perform solo physical activity than group and engaged in more solitary physical activity.

The original TPB model (Ajzen, 2001, Model 1) was examined first (Section 5.2) followed by the expanded TPB to evaluate the differences between self-efficacy and controllability in group and solo physical activity models (Section 5.3) followed by the augmentation of the TPB model by perceived autonomous support (PAS, Chatzisarantis, Hagger and Brickell, 2006). The models were prepared for SEM analysis together to ensure samples were comparable.

Table 5.8 Differences between Group and Solo Physical Activity and TPB Components

TPB Component		N	Mean	SD	T-Test
Instrumental Attitude	Group	206	15.55	5.06	t(205)=9.79, p<0.01
	Solo	206	18.97	3.29	
Affective Attitude	Group	206	13.34	5.53	t(205)=1.13, p=0.26
	Solo	206	13.85	5.24	
Attitude	Group	206	28.90	9.91	t(205)=5.33, p<0.01
	Solo	206	32.82	7.58	
Injunctive Norm	Group	210	8.79	2.91	t(209)=4.71, p<0.01
	Solo	210	9.90	2.34	
Descriptive Norm	Group	210	9.86	3.73	t(209)=5.97, p<0.01
	Solo	210	11.73	3.65	
Subjective Norm	Group	210	18.65	5.83	t(209)=6.27, p<0.01
	Solo	210	21.63	4.92	
Perceived Autonomy Support	Group	210	27.18	8.18	t(209)=3.94, p<0.01
	Solo	210	29.88	7.96	
Self-Efficacy	Group	210	12.59	6.31	t(209)=8.11, p<0.01
	Solo	210	16.66	4.76	
Controllability	Group	210	14.71	4.65	t(209)=5.97, p<0.01
	Solo	210	16.54	3.90	
Perceived Behavioural Control	Group	210	27.30	9.37	t(209)=8.56, p<0.01
	Solo	210	33.20	7.46	
Intention to Engage in Physical Activity	Group	208	5.94	4.25	t(207)=10.81, p<0.01
	Solo	208	11.02	5.80	
Physical Activity (MET/2 weeks)	Group	125	603.08	1051.39	t(124)=3.17, p<0.01
	Solo	125	1212.71	1862.44	

5.8.1 Data screening

In preparation for SEM analysis, data were screened for missing data, outliers, and assessed for normality and multicollinearity. Each individual iteration of the TPB model, including the original model (Ajzen, 2001), the expanded model (where PBC is split its two components) and the model augmented by perceived autonomous support (PAS) as specified by Chatzisarantis, Hagger and Brickell (2008) was examined for univariate and multivariate outliers (Table 5.9). Potential extreme univariate outliers were identified as a z-score greater than 3.29 (Tabachnick & Fidell, 2007, p73). Five univariate outliers were identified for age, four for solo physical activity, one for intention to engage in group physical activity and two for group physical activity. After examination these outliers were not excluded as responses were legitimate and satisfied inclusion criteria.

Multivariate outliers were identified through Mahalanobis distance, Cook's distance and leverage statistics. Gao, Mokhtarian and Johnston (2008) report that transformation alone is unlikely to lead to a multivariate normal distribution as transformation has only a minor effect when univariate non-normality is moderate or slight. Deleting outliers lowers multivariate skewness and kurtosis. The advantage of deleting outliers over transforming the data to achieve normality is that it retains the assumption of linearity. However the removal of outliers will reduce model power (Gao, Mokhtarian & Johnston, 2008). The minimum Mahalanobis distance to detect a multivariate outlier is set at a chi-square value using the number of independent variables as degrees of freedom where $p<0.001$ (Tabachnick & Fidell, 2007, p74). The critical chi-square values based on two, three and four independent variables were 13.82, 16.27, and 18.47, respectively. Mahalanobis distances which exceeded the appropriate values were removed. Cook's statistic should not exceed 1.00 (Tabachnick & Fidell, 2007, p75), therefore no outliers were identified using Cook's distance. Leverage statistics with values greater than three times the average ([k+1]/n) were considered to have undue influence (Stevens, 1992), these outliers were identified and excluded.

All multivariate outliers from the three models were excluded creating a single sample for group and solo physical activity to evaluate models for best fit. Thirty outliers were removed from group physical activity analysis, and 28 from solo physical activity.

Table 5.9 Identification of Multivariate Outliers in Group and Solo Physical Activity Models

		Group Physical Activity			Solo Physical Activity		
Model Iteration	Statistic	Intention	Behaviour	Total Outliers	Intention	Behaviour	Total Outliers
1	Mahalanobis	0	0		3	2	
	Leverage	2	18		7	12	
	Total	2	18	20	7	11	16
2	Mahalanobis	2	0		3	2	
	Leverage	2	16		7	20	
	Total	2	16	16	7	20	21
3	Mahalanobis	2	0		2	1	
	Leverage	2	18		5	13	
	Total	2	18	18	5	13	15
Combined outliers				30			28

As previously mentioned, missing data were treated using Maximum Likelihood (ML) estimation which was employed for all analysis. As the data included missing values, Mardia's (1970) coefficient was not expressed and multivariate tests of skewness and kurtosis could not be evaluated. Hankins (2008) reports that ML is quite robust and is acceptable when the sample size is between 200 and 500, and the distribution is not overly non-normal.

Distribution of residuals in Normal Probability plots appeared reasonably acceptable but suggested some non-normality. Scatterplots indicated that standardised residuals were not evenly distributed therefore skewness and kurtosis values were inspected to confirm non-normal distributions. Univariate kurtosis and skewness statistics were examined (Table 5.10) which indicated acceptable kurtosis (univariate kurtosis <7, West, et al., 1995) for all variables and acceptable skewness for all variables except group and solo physical activity which indicated slight skew (univariate skewness <2, West et al., 1995).

To assess multicollinearity, tolerance statistics and the variance inflation factor (VIF) were inspected. VIF values greater than 10 and tolerance statistics less than 0.2 indicate multicollinearity (Field, 2005). All VIF values and tolerance statistics were acceptable and did not exceed these limits.

Outliers were removed for both group and solo physical activity, resulting in a sample size of 184 per group and 186 per solo physical activity models (descriptive statistics are displayed in Table 5.11). There were significant differences between all group and solo TPB components except for affective attitude, similar to original data set (Table 5.11).

Two hundred and fourteen participants completed the first questionnaire pack (relating to TPB constructs; attitude, subjective norm, PBC and intention to engage in physical activity), of these, 125 participants responded to the second questionnaire pack (relating to physical activity performed in previous two weeks since the first questionnaire pack) and 89 did not respond. There was no significant difference in age between those who responded ($M=27.07$, $SD=6.13$, $n=124$) and those who did not to the second questionnaire pack ($M=28.20$, $SD=7.72$, $n=89$), $t(211) = 1.19$, $p=0.24$. Likewise there were no significant differences between sex, relationship status, university, or level of university (Table 5.12). In addition, there were no significant differences in TPB constructs between those who responded to the second questionnaire pack and those who did not for the group physical activity model (Table 5.13) and solo (Table 5.14).

Table 5.10 Descriptive Statistics of Group and Solo Physical Activity and TPB Components After Data Screening

Activity Type	TPB Component	n	Mean	SD	Skewness Statistic	Skewness Std. Error	Kurtosis Statistic	Kurtosis Std. Error
Group Physical Activity	Affective Attitude	184	15.65	4.68	-0.69	0.18	-0.18	0.36
	Instrumental Attitude	184	13.18	5.51	-0.43	0.18	-0.95	0.36
	Attitude	184	28.84	9.53	-0.54	0.18	-0.57	0.36
	Injunctive Norm	182	8.67	2.85	0.08	0.18	-0.70	0.36
	Descriptive Norm	182	9.64	3.56	0.18	0.18	-0.75	0.36
	Subjective Norm	182	18.31	5.63	0.20	0.18	-0.68	0.36
	PAS	182	26.86	7.41	0.08	0.18	-0.41	0.36
	Self-Efficacy	182	12.46	5.91	-0.13	0.18	-1.29	0.36
	Controllability	182	14.85	4.30	-0.48	0.18	-0.44	0.36
	PBC	182	27.31	8.68	-0.44	0.18	-0.73	0.36
	Intention	181	5.39	3.34	1.03	0.18	0.08	0.36
	Physical Activity (MET/2weeks)	108	620.23	1059.34	2.27	0.23	5.57	0.46
Solo Physical Activity	Affective Attitude	180	19.41	2.53	-2.04	0.18	4.76	0.36
	Instrumental Attitude	180	14.43	4.88	-0.41	0.18	-0.73	0.36
	Attitude	180	33.84	6.48	-0.76	0.18	0.38	0.36
	Injunctive Norm	182	10.08	2.12	-0.15	0.18	0.23	0.36
	Descriptive Norm	182	11.98	3.36	-0.49	0.18	0.36	0.36
	Subjective Norm	182	22.05	4.36	-0.29	0.18	-0.11	0.36
	PAS	182	30.84	7.35	-0.12	0.18	-0.82	0.36
	Self-Efficacy	182	17.77	3.39	-1.09	0.18	0.51	0.36
	Controllability	182	16.96	3.31	-0.24	0.18	-1.15	0.36
	PBC	182	34.74	5.64	-0.62	0.18	-0.32	0.36
	Intention	181	11.76	5.46	-0.20	0.18	-0.98	0.36
	Physical Activity (MET/2weeks)	110	1228.53	1794.52	2.42	0.23	6.71	0.46

Table 5.11 Differences between Group and Solo Physical Activity and TPB Components After Data Screening

TPB Component		n	Mean	SD	T-Test
Instrumental Attitude	Group	184	15.65	4.68	t(282.70)= -9.55, p<0.01 (equal variances not assumed)
	Solo	180	19.41	2.53	
Affective Attitude	Group	184	13.18	5.51	t(358.45)= -2.29, p=0.02 (equal variances not assumed)
	Solo	180	14.43	4.88	
Attitude	Group	184	28.84	9.53	t(323.05)= -5.87, p<0.01 (equal variances not assumed)
	Solo	180	33.84	6.48	
Injunctive Norm	Group	182	8.67	2.85	t(334.60)= -5.34, p<0.01 (equal variances not assumed)
	Solo	182	10.08	2.12	
Descriptive Norm	Group	182	9.64	3.56	t(362)= -6.44, p<0.01
	Solo	182	11.98	3.36	
Subjective Norm	Group	182	18.31	5.63	t(340.62)= -7.09, p<0.01 (equal variances not assumed)
	Solo	182	22.05	4.36	
Perceived Autonomy Support	Group	182	26.86	7.41	t(362)= -5.14, p<0.01
	Solo	182	30.84	7.35	
Self-Efficacy	Group	182	12.46	5.91	t(288.22)= -10.52, p<0.01 (equal variances not assumed)
	Solo	182	17.77	3.39	
Controllability	Group	182	14.85	4.30	t(340.11)= -5.25, p<0.01 (equal variances not assumed)
	Solo	182	16.96	3.31	
Perceived Behavioural Control	Group	182	27.31	8.68	t(310.58)= -9.67, p<0.01 (equal variances not assumed)
	Solo	182	34.74	5.64	
Intention to Engage in Physical Activity	Group	181	5.39	3.34	t(297.96)= -13.38, p<0.01 (equal variances not assumed)
	Solo	181	11.76	5.46	
Physical Activity (MET/2 weeks)	Group	108	620.23	1059.34	t(177.35)= -3.05, p<0.01 (equal variances not assumed)
	Solo	110	1228.53	1794.52	

Table 5.12 Differences in Demographic Data between Responders and Non Responders to Second Questionnaire Pack (including Physical Activity Measure)

	Non-Responder		Responder		Chi-Square
	n	%	N	%	
Sex					
Male	30	33.7	45	36.0	x2 (1, N=214) = 0.12, p=0.73
Female	59	66.3	80	64.0	
Total	89	100.0	125	100.0	
Relationship Status					
Single	31	34.8	40	32.0	
In A Relationship	21	23.6	42	33.6	x2 (3, N=214) = 2.82, p=0.42
Co-habiting/Married	36	40.4	41	32.8	
Declined To Answer	1	1.1	2	1.6	
Total	89	100.0	125	100.0	
University					
University of Edinburgh	52	58.4	87	69.6	
Heriot-Watt University	11	12.4	16	12.8	
Napier University	24	27.0	21	16.8	x2 (3, N=214) = 4.34, p=0.23
Queen Margaret University	2	2.2	1	.8	
Total	89	100.0	125	100.0	
University Level					
Undergraduate	40	44.9	44	35.2	x2 (1, N=214) = 2.07, p=0.15
Postgraduate	49	55.1	81	64.8	
Total	89	100.0	125	100.0	

Table 5.13 Differences between TPB Constructs of Responders and Non-Responders to Physical Activity Measure for Group Physical Activity Model

TPB Component		N	Mean	SD	T-Test
Instrumental Attitude	Non-Responder	76	16.01	4.90	t(182) = 0.88, p=0.38
	Responder	108	15.40	4.52	
Affective Attitude	Non-Responder	76	12.50	5.66	t(182) = -1.42, p=0.16
	Responder	108	13.67	5.38	
Attitude	Non-Responder	76	28.51	9.91	t(182) = -0.39, p=0.70
	Responder	108	29.06	9.29	
Injunctive Norm	Non-Responder	74	8.62	2.85	t(180) = -0.19, p=0.85
	Responder	108	8.70	2.86	
Descriptive Norm	Non-Responder	74	9.82	3.55	t(180) = 0.57, p=0.57
	Responder	108	9.52	3.57	
Subjective Norm	Non-Responder	74	18.45	5.72	t(180) = 0.26, p=0.79
	Responder	108	18.22	5.59	
Perceived Autonomy Support	Non-Responder	74	27.15	7.61	t(180) = 0.43, p=0.67
	Responder	108	26.67	7.30	
Self-Efficacy	Non-Responder	74	12.61	5.71	t(180) = 0.28, p=0.78
	Responder	108	12.36	6.07	
Controllability	Non-Responder	74	15.53	4.44	t(180) = 1.77, p=0.08
	Responder	108	14.39	4.16	
Perceived Behavioural Control	Non-Responder	74	28.14	8.63	t(180) = 1.06, p=0.29
	Responder	108	26.75	8.71	
Intention to Engage in Physical Activity	Non-Responder	74	5.00	3.12	
	Responder	107	5.66	3.47	t(179) = -1.32, p=0.19

Table 5.14 Differences between TPB Constructs of Responders and Non-Responders to Physical Activity Measure for Solo Physical Activity Model

TPB Component		N	Mean	SD	T-Test
Instrumental Attitude	Non-Responder	70	19.40	2.65	t(178) = -0.02, p=0.98
	Responder	110	19.41	2.46	
Affective Attitude	Non-Responder	70	14.30	4.96	t(178) = -0.29, p=0.77
	Responder	110	14.52	4.84	
Attitude	Non-Responder	70	33.70	6.62	t(178) = -0.23, p=0.82
	Responder	110	33.93	6.41	
Injunctive Norm	Non-Responder	72	9.99	2.15	t(180) = -0.47, p=0.64
	Responder	110	10.14	2.11	
Descriptive Norm	Non-Responder	72	12.33	3.33	t(180) = 1.15, p=0.25
	Responder	110	11.75	3.38	
Subjective Norm	Non-Responder	72	22.32	4.26	t(180) = 0.66, p=0.51
	Responder	110	21.88	4.43	
Perceived Autonomy Support	Non-Responder	72	30.08	6.94	t(180) = -1.13, p=0.26
	Responder	110	31.34	7.59	
Self-Efficacy	Non-Responder	72	17.43	3.55	t(180) = -1.11, p=0.27
	Responder	110	18.00	3.27	
Controllability	Non-Responder	72	17.24	3.56	t(180) = 0.90, p=0.37
	Responder	110	16.78	3.15	
Perceived Behavioural Control	Non-Responder	72	34.67	6.30	t(131.17) = -0.13, p=0.90 (equal variances not assumed)
	Responder	110	34.78	5.19	
Intention to Engage in Physical Activity	Non-Responder	72	10.96	5.77	t(140.99) = -1.57, p=0.12 (equal variances not assumed)
	Responder	109	12.28	5.20	

5.8.2 Hypothesis 1

The Theory of Planned Behaviour (TPB) model will explain more variance in group physical activity intention and behaviour than solo physical activity intention and behaviour.

A multigroup SEM model based on the Theory of Planned Behaviour (Ajzen, 2001, Model 1) was used to model group and solo physical activity behaviour. Chi-square tests indicated that the model overall was a significantly good fit, and individually for group and solo physical activity (Table 5.15). Inspection of RMSEA and CFI indices revealed good fit for both types of physical activity (Table 5.12). The TPB predicted more variance overall including intention and behaviour for group physical activity (53.97%) than solo (33.82%).

Both standardised (β) and unstandardised (b) coefficients were reported (Table 5.15). Standardised effects are sample specific and not stable across different samples however they are useful for comparing variables within a model. The standardised solutions for Model 1 are displayed in Figure 5.2 and Figure 5.3. Unstandardised effects are useful for comparing change across different models and samples (Schumacker & Lomax, 2004, p.56; Menard, 2010, p.215) and are reported below.

a) Intention

The original TPB model (Model 1) predicted greater variance in intention to engage in group physical activity (52.27%) than to engage in solo physical activity (32.33%). Of the three antecedents of intention, PBC made the greatest contribution to intention to engage in group ($b=0.16$, $p<0.01$) and solo physical activity ($b=0.45$, $p<0.01$). This was followed by subjective norm ($b=0.12$, $p=0.01$), then attitude ($b=0.11$, $p<0.01$) for intention to engage in group physical activity, and attitude ($b=0.14$, p0.02) then subjective norm ($b=0.12$, $p=0.16$) for solo.

b) Behaviour

The original TPB model (Model 1) predicted greater variance in group physical activity (19.16%) than solo (14.23%). Of the two antecedents of behaviour, only intention made a significant contribution to physical activity in both group (b=84.91, p=0.01) and solo physical activity models (87.32, p=0.02). PBC did not contribute significantly to physical activity in either group (26.15, p=0.06) or solo physical activity models (b=52.20, p=0.16).

Table 5.15 Model Fit, Standardised and Unstandardised Coefficients for Constrained and Partially Constrained TPB Models

Relationship	Model 1 (Unconstrained)				Model 2 (Partially Constrained)			
	Group Physical Activity		Solo Physical Activity		Group Physical Activity		Solo Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)	b (SE)	β (SE)	b (SE)	β (SE)
Intention								
Attitude	0.11 (0.02)***	0.31 (0.06)***	0.14 (0.06)*	0.17 (0.07)*	0.11 (0.02)***	0.32 (0.06)***	0.11 (0.02)***	0.14 (0.03)***
Subjective Norm	0.12 (0.04)***	0.20 (0.06)***	0.12(0.08)	0.09 (0.07)	0.12 (0.03)***	0.20 (0.06)***	0.12 (0.03)***	0.09 (0.03)***
PBC	0.16 (0.02)***	0.40 (0.05)***	0.45 (0.06)***	0.46 (0.06)***	0.15 (0.02)***	0.40 (0.05)***	0.46 (0.06)***	0.48 (0.05)***
Physical Activity								
Intention	84.91 (34.42)**	0.27 (0.11)*	87.32 (37.09)*	0.26 (0.11)*	90.48 (24.63)***	0.29 (0.08)***	90.48 (24.63)***	0.28 (0.07)***
PBC	26.15 (13.67)	0.22 (0.11)	52.20 (36.97)	0.16 (0.11)	27.37 (12.17)*	0.22 (0.10)*	27.37 (12.17)*	0.09 (0.04)*
r^2 Intention	0.52		0.32		0.53		0.31	
r^2 Behaviour	0.19		0.14		0.21		0.11	
r^2 Overall	0.54		0.34		0.53		0.32	
X^2 by group	X^2 (3) = 0.82, p=0.85		X^2 (3) = 2.31, p=0.51		A		A	
X^2 overall	X^2 (7)= 3.13, p=0.87				X^2 (11) = 4.10, p=0.97			
RMSEA	0.00				0.00			
CFI	1.00				1.00			

a Not reported because of constraints between groups
* p<0.05; **p<0.01; ***p<0.001

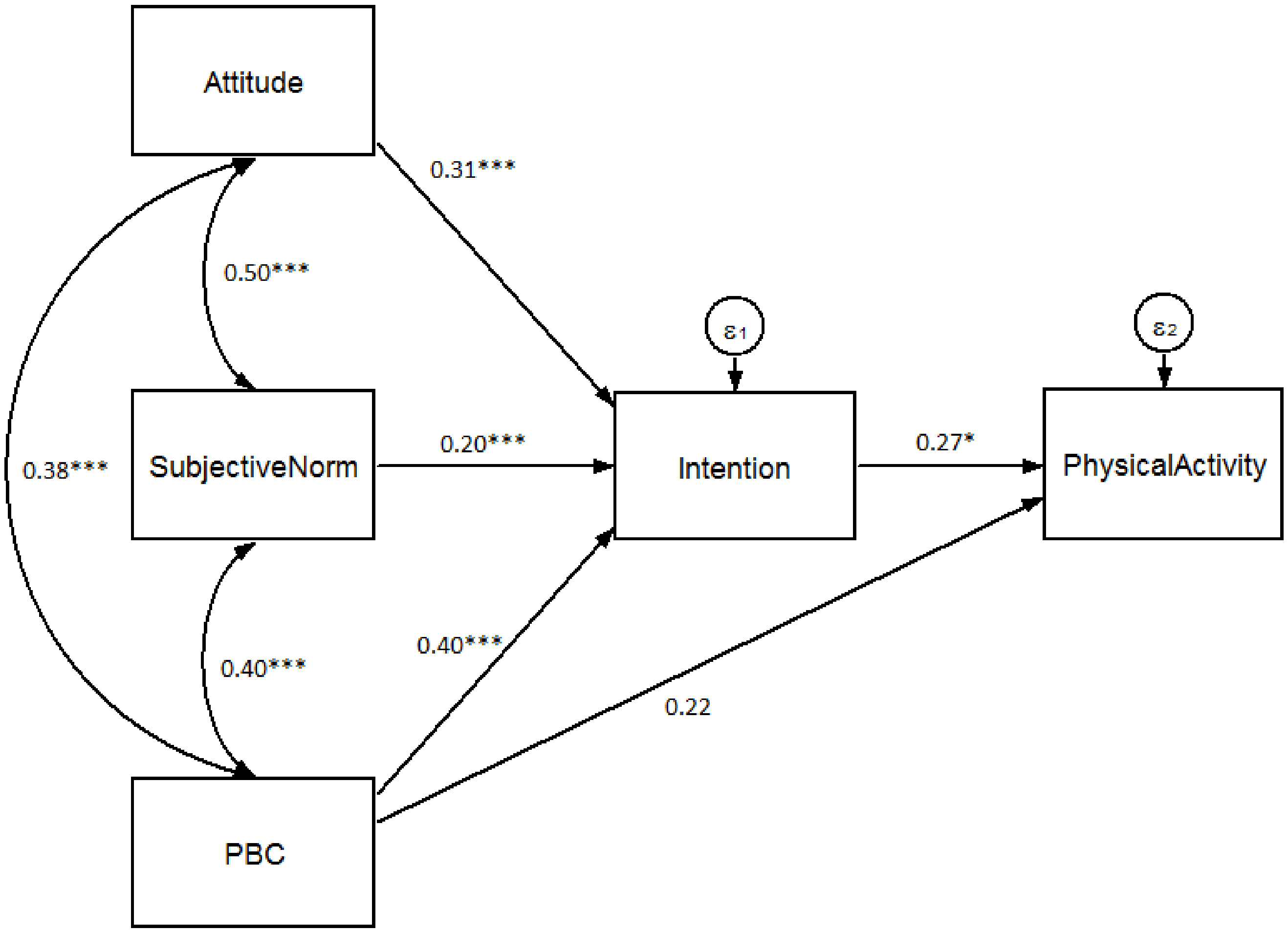

Figure 5.2 Standardised Solution of the Theory of Planned Behaviour Model (Group Physical Activity, Model 1)

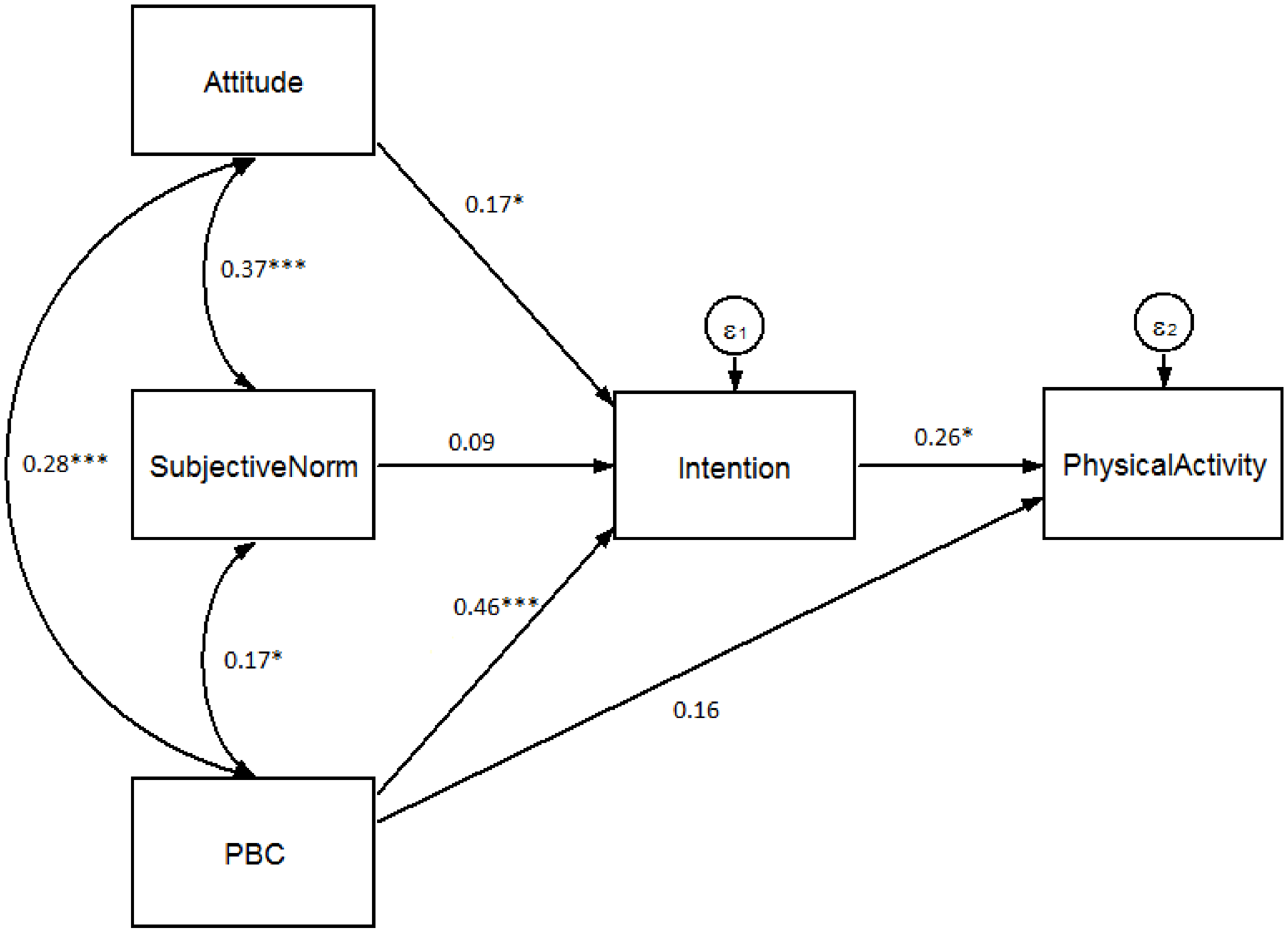

Figure 5.3 Standardised Solution of the Theory of Planned Behaviour Model (Solo Physical Activity, Model 1)

5.8.3 Hypothesis 2

Components from the Theory of Planned Behaviour (TPB) will be more predictive of group physical activity than solo.

Wald's test of group invariance for parameters was conducted to investigate differences in paths of TPB constructs between group and solo physical models (Table 5.16). A significant difference indicates that constraining this parameter would significantly degrade the model.

Table 5.16 Wald's Test of Group Invariance for Parameters between Group and Solo Physical Activity TPB Model (Ajzen, 2001, Model 1)

Relationship	X^2	Df	Significance
Intention			
Attitude	0.28	1	0.60
Subjective Norm	<0.01	1	0.99
PBC	19.63	1	<0.01
Behaviour			
Intention	<0.01	1	0.96
PBC	0.44	1	0.51

Only one significant difference was found; while PBC significantly contributed to intention in both models, PBC appeared made a greater contribution to intention in the solo physical activity model ($b=0.45$, $p<0.01$) than group ($b=0.16$, $p<0.01$).

The Wald test of group invariance for parameters is considered approximate, therefore a second approach comparing a subsequent model where parameters hypothesised to be invariant are constrained to be equal and examined with a chi-square difference test is required (Chen, Sousa & West, 2005; Kline 1998).

Therefore the second model was constructed where all paths were constrained between group and solo physical activity models excluding that of PBC on intention (Model 2). Despite the extra constraints, the significance and good fit of the model did not degrade (Table 5.15). A chi-square difference test indicated the constrained model did not fit significantly worse than the constrained (ΔX^2 [4]=0.97, $p=0.91$), thus supporting the assumption of invariance for all parameters excluding PBC on intention.

To confirm that the contribution of PBC on intention was significantly different in group and solo physical activity models, a third model (Model 3) where all paths were fully constrained was constructed and when compared with the unconstrained model. The fully constrained model demonstrated poor and nonsignificant fit (X^2 [11]=26.33, $p<0.01$, RMSEA=0.09, CFI=0.93 (standardised and unstandardised coefficients can be found in G1). The chi-square difference (ΔX^2[4]=23.20, $p<0.01$) indicated the model significantly degraded when the path between PBC and intention was constrained to be equal, thus supporting the assumption of noninvariance.

The model was expanded and reconstructed to compare the differences in contributions from PBC components: self-efficacy and controllability between group and solo physical activity models (Figure 5.4, Figure5.5). As with the previous configuration, the model demonstrated significant and good fit (Table 5.17). Wald's test of group invariance for parameters found a significant difference between group and solo physical activity models on the parameter of self-efficacy to intention only (Table 5.18). As before an unconstrained and partially constrained model was compared using a chi-square difference test (ΔX^2 [5] = 3.48, p=0.63), and as there was not a significant degradation, the assumption of invariance of the constrained parameters can be accepted.

A model with all paths fully constrained demonstrated poor and nonsignificant fit (Model 6, X^2 [13] = 41.77, $p<0.01$, RMSEA=0.11, CFI=0.89, standardised and unstandardised coefficients reported in G2), and indicated significant degration compared with the unconstrained model (ΔX^2 [5]=37.72, $p<0.01$) therefore, confirming noninvariance of self-efficacy on intention between group and solo physical activity models.

Table 5.17 Model Fit, Standardised and Unstandardised Coefficients for Constrained and Partially Constrained Expanded TPB Models

Relationship	Model 4 (Unconstrained)				Model 5 (Partially Constrained)			
	Group Physical Activity		Solo Physical Activity		Solo Physical Activity		Group Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)	b (SE)	β (SE)	b (SE)	β (SE)
Intention								
Attitude	0.06 (0.02)**	0.17 (0.07)**	0.11 (0.06)	0.13 (0.07)*	0.07 (0.02)***	0.20 (0.06)***	0.07 (0.02)***	0.08 (0.03)***
Subjective Norm	0.09 (0.03)**	0.15 (0.06)*	0.08 (0.08)	0.06 (0.06)	0.09 (0.03)**	0.15 (0.05)**	0.09 (0.03)**	0.07 (0.03)**
Self-Efficacy	0.32 (0.04)***	0.56 (0.07)***	0.85 (0.11)***	0.53 (0.06)***	0.30 (0.04)***	0.54 (0.06)***	0.90 (0.10)***	0.56 (0.05)***
Controllability	-0.03 (0.04)	-0.03 (0.06)	0.07 (0.11)	0.04 (0.06)	-0.01 (0.04)	-0.01 (0.05)	-0.01 (0.04)	<0.01 (0.02)
Behaviour/PA								
Intention	87.34 (39.62)*	0.28 (0.12)*	103.59 (38.66)**	0.31 (0.11)**	98.48 (26.58)***	0.31 (0.08)***	98.48 (26.58)***	0.30 (0.08)
Self-Efficacy	23.75 (24.17)	0.13 (0.14)	-21.42 (61.39)	-0.04 (0.12)	13.57 (20.26)	0.08 (0.11)	13.57 (20.26)	0.03 (0.04)
Controllability	28.53 (24.45)	0.12 (0.10)	110.91 (53.33)*	0.20 (0.10)*	43.56 (22.29)	0.18 (0.09)*	43.56 (22.29)	0.08 (0.04)
r^2 Intention	0.57		0.39		0.57		0.38	
r^2 Behaviour	0.19		0.16		0.21		0.12	
r^2 Overall	0.59		0.41		0.59		0.39	
X^2 By Group	(3) = 1.01, p=0.80		(3) = 3.04, p=0.39		A		a	
X^2 Overall	X2(8)=4.05, p=0.85				X2 (13)= 7.53, p=0.87			
RMSEA	0.00				1.00			
CFI	1.00				0.00			

a Not reported because of constraints between groups
* p<0.05; **p<0.01; ***p<0.001

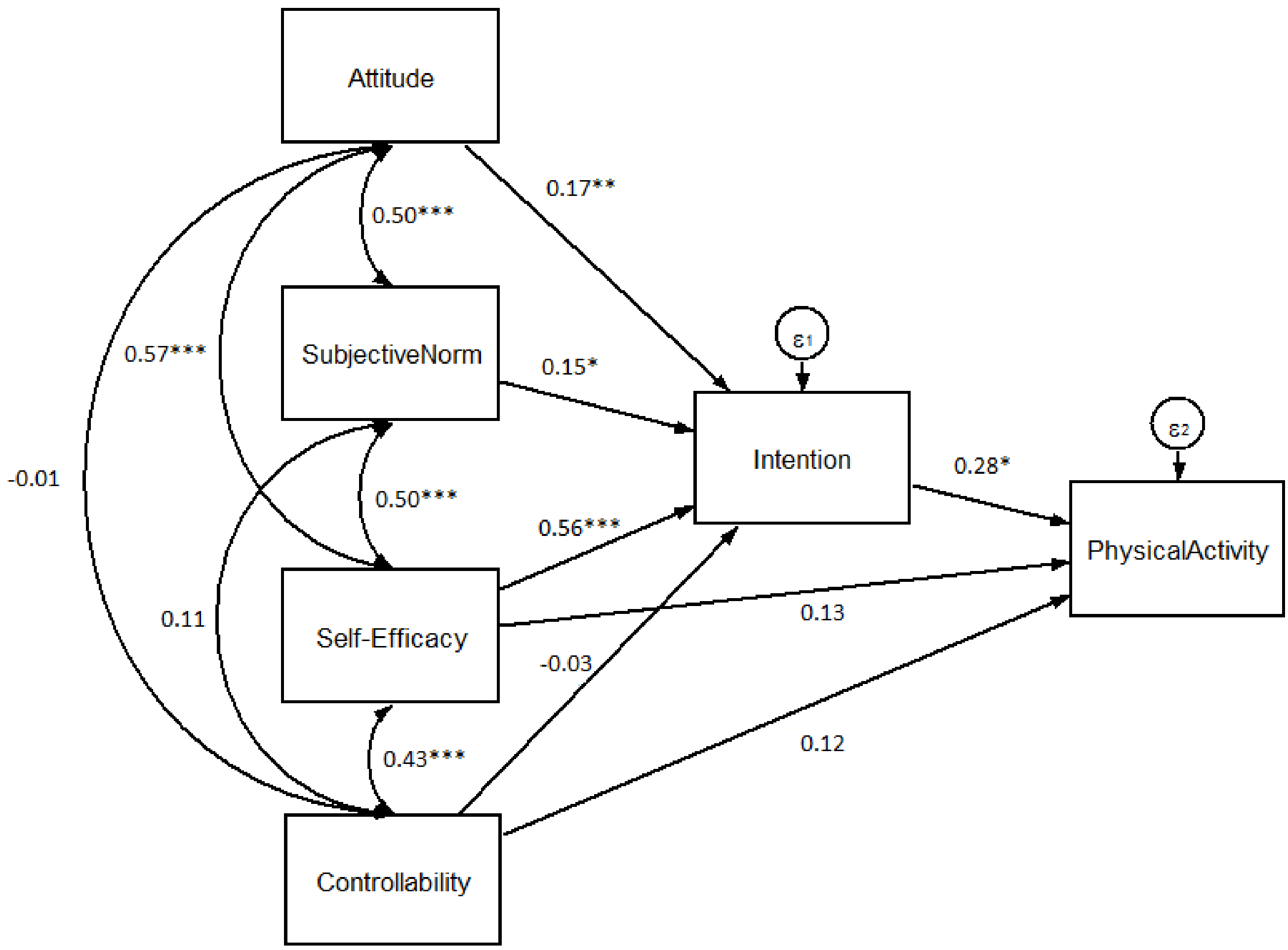

Figure 5.4 Standardised Solution of the Expanded Theory of Planned Behaviour Model (Group Physical Activity, Model 4)

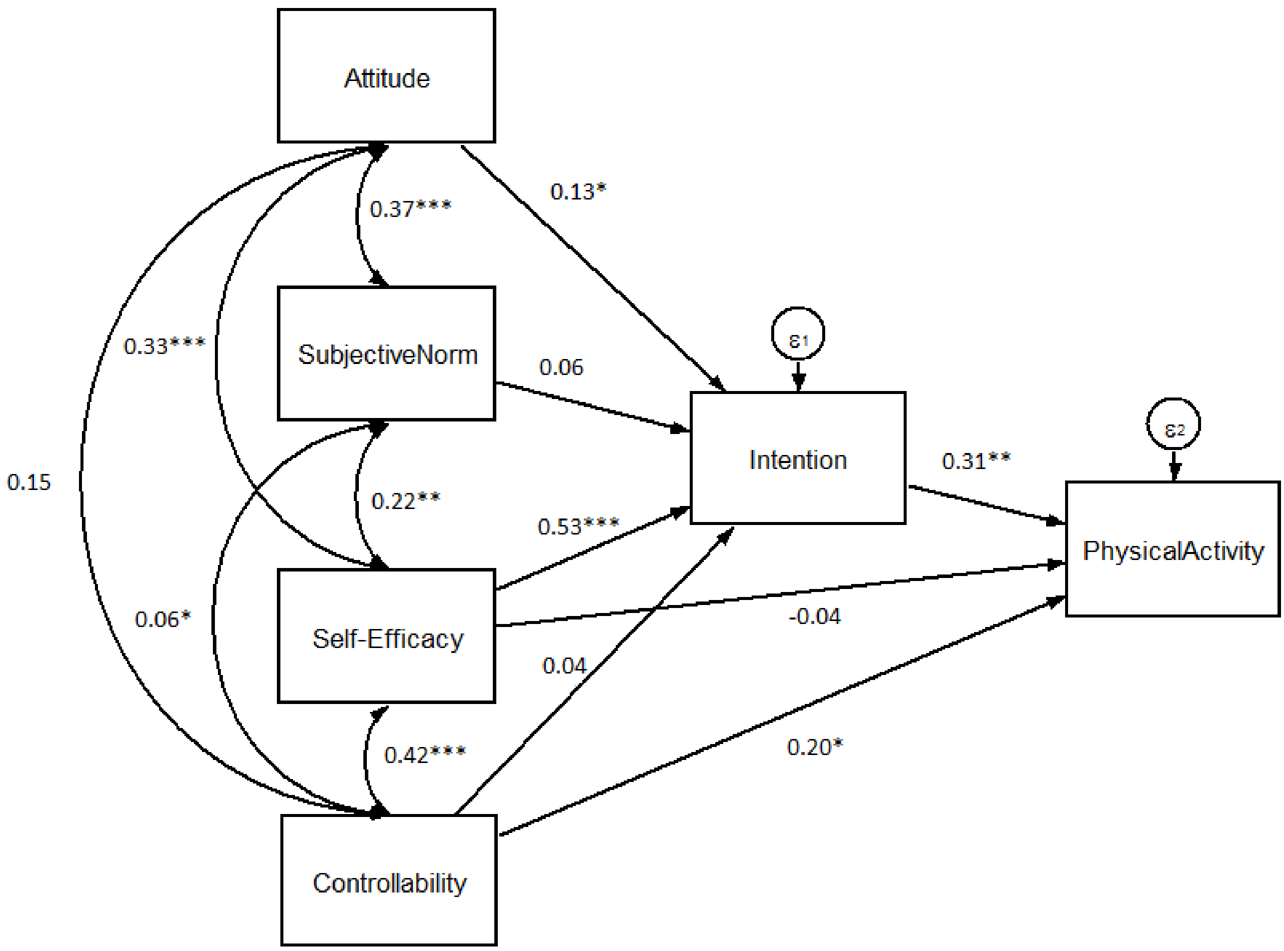

Figure5.5 Standardised Solution of the Expanded Theory of Planned Behaviour Model (Solo Physical Activity, Model 4)

Table 5.18 Wald's Test of Group Invariance for Parameters between Group and Solo Physical Activity Expanded TPB Model (Model 4)

Relationship	X^2	Df	Significance
Intention			
Attitude	0.68	1	0.41
Subjective Norm	0.01	1	0.91
Self-Efficacy	21.01	1	<0.01
Controllability	0.66	1	0.42
Behaviour			
Intention	0.09	1	0.77
Self-Efficacy	0.47	1	0.49
Controllability	2.00	1	0.16

5.8.4 Hypothesis 3

The Theory of Planned Behaviour (TPB) model will better explain group and solo physical activity when augmented by Perceived Autonomous Support (PAS).

A model was constructed to include PAS as specified by Chatzisarantis, Hagger and Brickell (2006), with PAS contributing to attitudes, intention and physical activity (Model 7). The model demonstrated nonsignificant and unacceptable fit overall (X^2 [14]= 35.96, $p<0.01$, RMSEA=0.09, CFI=0.94, standardised and unstandardised coefficients are found in G3) and for both the group physical activity model (X^2 [5]= 19.20, $p<0.01$) and solo (X^2 [6]= 16.77, $p=0.01$). Therefore this model could not be accepted for further path analysis.

a) Model Modification Including PAS

Due to the poor fit of the model specified by Chatzisarantis, Hagger and Brickell (2006), the best fit of PAS within TPB framework with the current data was investigated. Using the expanded TPB model including self-efficacy and controllability inspection of modification indices (MI) were used to guide the respecification of the model.

b) Model Respecification

Modification indices report the extent to which the X^2 fit statistic would change if any of the fixed parameters within the structural model were freed (Jöreskog &Sörbom, 1998), such as drawing a parameter (or path) between two variables. A MI greater than 3.84 indicates there would be a significant improvement in the model X^2 statistic fit ($p<0.05$) therefore this parameter may be considered for addition to the model (Schermelleh-Engel, Moosbrugger & Müller, 2003). Acock (2013, p.27) recommends only one parameter should be changed at a time as MI indicate the improvement for the addition a single parameter and are not additive. The model respecification process required two steps (standardised and unstandardised coefficients for steps one can be found in G4).

Step one represented the expanded TPB model with PAS included as a correlate of the antecedents of intention (Model 8). This model resulted in a significant but good fit overall (χ^2 [12]= 24.16, p=0.02, RMSEA=0.07, CFI=0.95, Table 5.19) but not for group and solo physical activity models separately (χ^2 [5]= 12.96, p=0.02 and χ^2 [5]= 11.20, p=0.05, respectively). MIs indicated the overall fit of the model would improve if PAS was allowed to directly contribute to intention for group physical activity only (MI=11.77, $p<0.01$), this path was added and the overall model further examined in step two (Model 9).

Step two (Model 9) demonstrated a non-significant and good fit (χ^2 (12) = 12.03, p=0.44, RMSEA<0.01, CFI=1.00) and was non-significant for both the group physical activity model (χ^2 [4]=0.83, p=0.93) and solo (χ^2 [5]= 11.20, p=0.05) although this was borderline. Inspection of MI indicated no additional parameters would improve model fit.

Overall, the expanded TPB model augmented by PAS as described in step 2 (Model 9) explained more combined variance of intention and behaviour of group physical activity (56.97%) than solo (33.88%).

c) Intention

The expanded TPB model augmented by PAS (Model 9) predicted greater variance in intention to engage in group physical activity (55.38%) than to engage in solo physical activity (32.39%).

For the group physical activity model, PBC ($b=0.13$, $p<0.01$) made the greatest contribution intention followed by PAS ($b=0.11$, $p=0.03$), subjective norm ($b=0.08$, $p=0.02$) and attitude ($b=0.08$, $p<0.01$). Likewise, for the solo physical activity model PBC ($b=0.45$, $p<0.01$) made the greatest contribution to intention, which was followed by attitude ($b=0.15$, $p=0.02$). However subjective norm did not contribute significantly ($b=0.12$, $p=0.16$).

d) Behaviour

The expanded TPB model augmented by PAS (Model 11) predicted greater variance in group physical activity (19.17%) than solo (14.23%).

In both group and solo physical activity models only intention contributed significantly to physical activity ($b=85.01$, $p=0.02$, $b=87.33$, respectively). PBC did not significantly contribute to physical activity in group ($b=26.11$, $p=0.06$) or solo physical activity models ($b=52.20$, $p=0.14$).

5.8.5 Hypothesis 4

Perceived autonomy support (PAS) will be a more important predictor of group physical activity than they will be of solo physical activity

Parameter invariance testing as described previously could not be conducted as parameters involving PAS were not identical between group and solo physical activity models. PAS directly contributed to intention in the group physical activity model ($b=0.11$, $p<0.01$), but did not in the solo physical activity model.

Table 5.19 Model Fit, Standardised and Unstandardised Coefficients for Constrained and Partially Constrained Expanded TPB Models

Relationship	Model 9 (Unconstrained)			
	Group Physical Activity		Solo Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)
Intention				
Attitude	0.08 (0.02)***	0.24 (0.06)***	0.15 (0.16)*	0.17 (0.07)*
Subjective Norm	0.08 (0.04)*	0.14 (0.06)*	0.12 (0.08)	0.09 (0.07)
PBC	0.13 (0.02)***	0.33 (0.06)***	0.45 (0.06)***	0.46 (0.06)***
PAS	0.11 (0.03)***	0.24 (0.07)***	No path	No path
Behaviour/PA				
Intention	85.01 (34.41)*	0.27 (0.11)*	87.33 (37.09)*	0.26 (0.11)*
PBC	26.11 (13.67)	0.22 (0.11)	52.20 (36.97)	0.16 (0.11)
r^2 Intention	0.55		0.32	
r^2 Behaviour	0.19		0.14	
r^2 Overall	0.57		0.34	
X^2 By Group	X^2 (4) = 0.83, p=0.94		X^2 (5) = 11.20, p=0.05	
X^2 Overall	X^2 (12) = 12.03, p=0.44			
RMSEA	<0.01			
CFI	1.00			

* p<0.05; **p<0.01; ***p<0.001

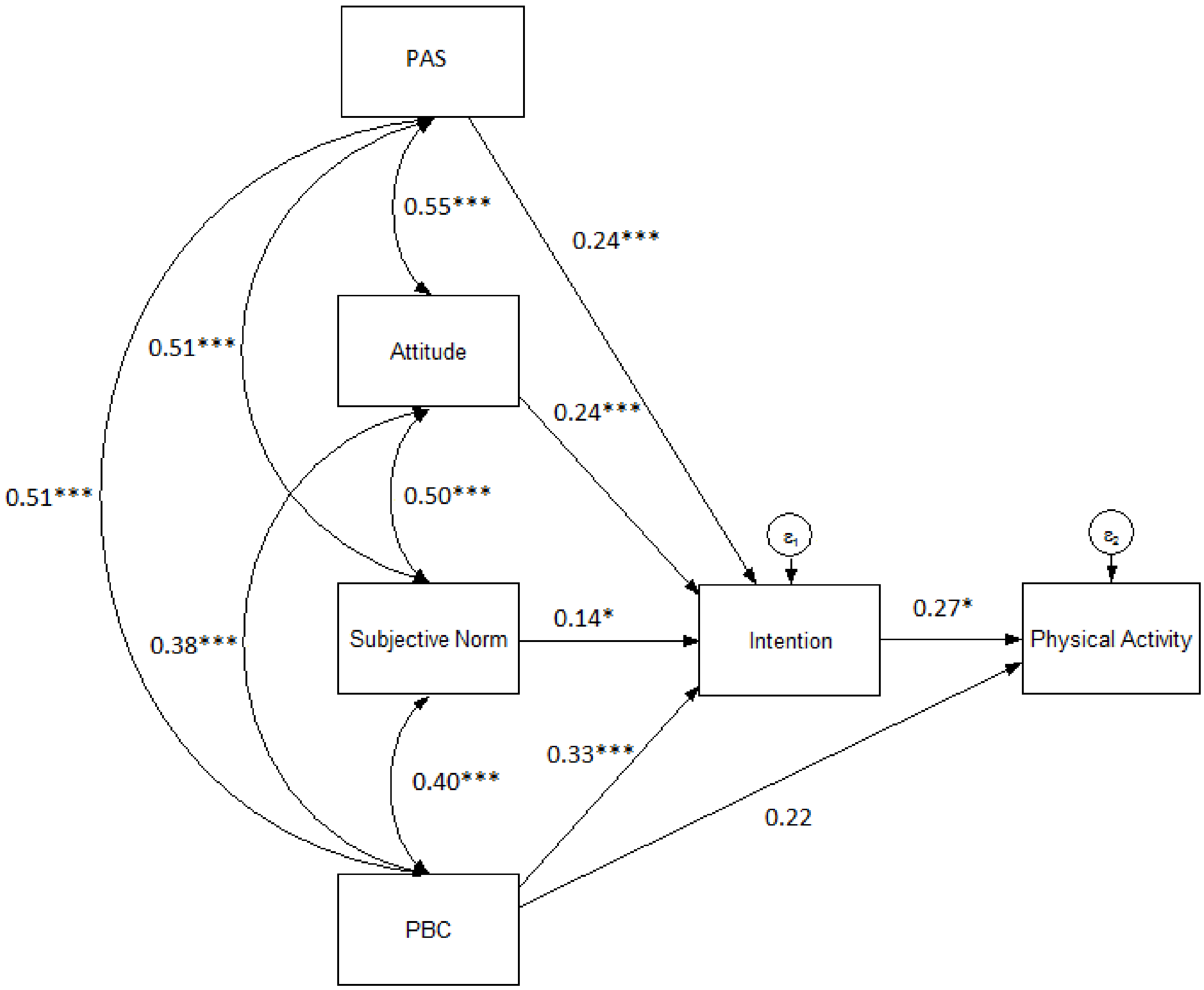

Figure 5.6 Standardised Solution of the Expanded TPB Model Augmented by PAS (Group Physical Activity, Model 11)

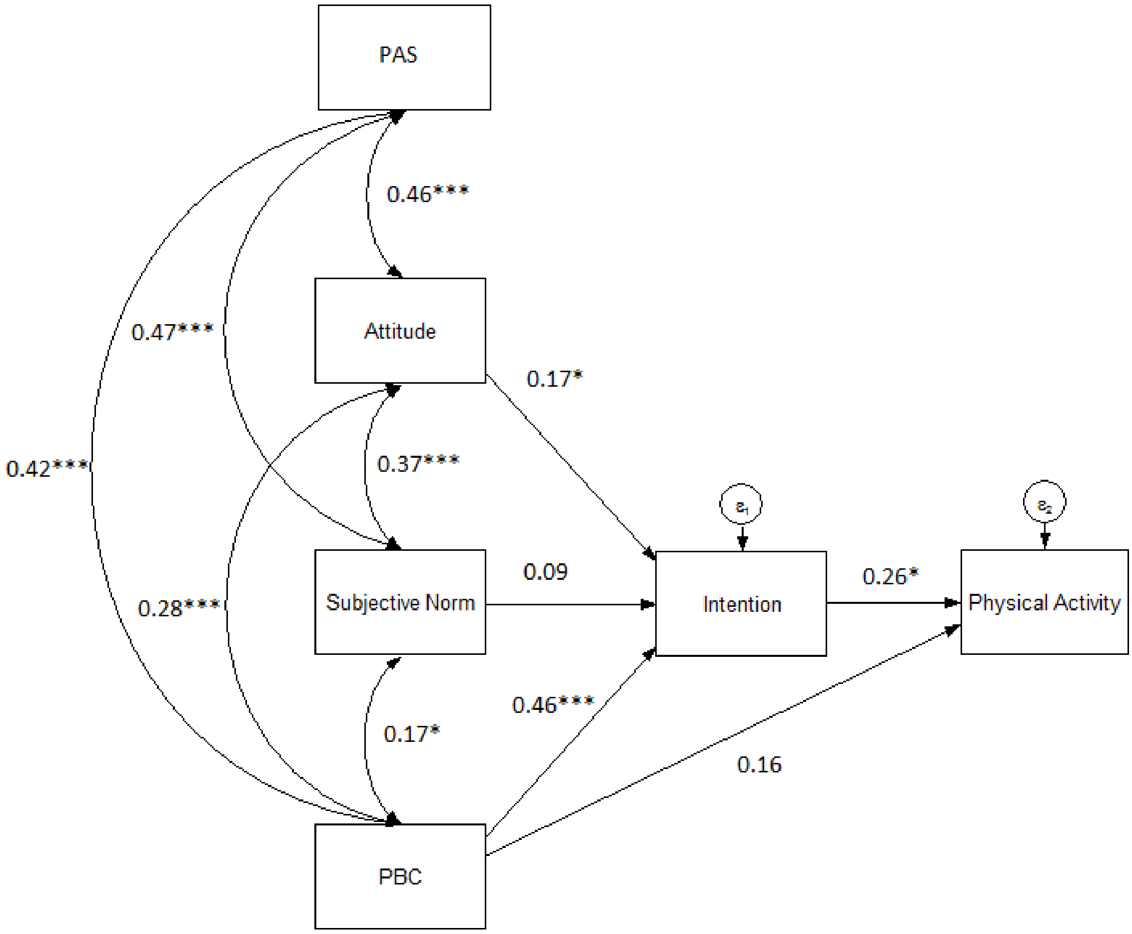

Figure 5.7 Standardised Solution of the Expanded TPB Model Augmented by PAS (Solo Physical Activity, Model 11)

5.9 **Discussion**

Using the Theory of Planned Behaviour (TPB, Ajzen, 2001) this study compared group and solo physical activity with a multigroup SEM model. The model was expanded and reconstructed to further investigate the differences in contributions from perceived behavioural control components, self-efficacy and controllability between group and solo physical activity models. The model was expanded again to include Perceived Autonomous Support as specified by Chatzisarantis, Hagger and Brickell (2006), which resulted in a significant and unacceptable fit which was not appropriate for further path analysis. Therefore the model was respecified, guided by modification indices (MI) before comparing the contribution of PAS between group and solo physical activity models.

5.9.1 Difference in predicted variance of intention and behaviour of group physical activity compared to solo

As predicted by the first hypothesis, intention to engage in, and group physical activity behaviour was better explained by the TPB than intention to engage in solo physical activity. This follows a similar pattern relating to intention found by Eves, Hoppéa and McLaren (2003) where the TPB better explained intention to engage in group activities (such as team sports and dancing) than solo (such as cycling). However the current study did not support Eves et al.’s (2003) findings relating to behaviour where solo physical activity behaviour (cycling) was better explained than group (including team sports and dancing) as slightly more variance of group physical activity behaviour was explained than solo in the present study. A caveat of Eves et al.'s (2003) study is that specific activities were not specified as group or solo based, therefore any conclusions drawn currently are prospective.

The amount of variance explained in intention to engage in group physical activity was similar to that found by Blue (1995), Godin and Kok (1996) and Hagger, Chatzisarantis and Biddle’s (2002) reviews, although the variance of intention to engage in solo physical activity was somewhat lower. Both group and solo physical activity behaviour were explained less well than that found in Blue (1995), Godin and Kok (1996, and Hagger, et al.’s (2002) reviews. This suggests there were additional unmeasured factors involved in predicting group and solo physical activity in the current data.

It has been consistently found that intention does not reliably lead to behavioural engagement, known as the “intention-behaviour gap” (Sheeran, 2002; Conner & Armitage, 1998; Godin & Kok, 1996). Sheeran’s (2002) review concludes the discrepancy between intention and behaviour is mainly due to individuals who intend to engage in a behaviour but fail to act, rather than those who do not intend to act but then do. Conner and Norman (2005) suggest that an intention can only be translated into action if they possess “intention activation” and “intention elaboration”.

Intention activation refers to the extent to which contextual demands interfere with a focal intention relative to other intentions (Conner & Norman, 2005). Conner and Norman (2005) report that when goals involve short term affective costs or require mobilization of effort, then intentions may be especially vulnerable to more enjoyable or pressing alternatives. This may result in goal reprioritisation; for example, Milne et al. (2002) found that 45% of participants who did not enact their intention to exercise stated they were "too busy". In addition, a decrease in the activation level of intention can result in memory failure. However this may be less likely for group physical activity as an individual may be reminded by other group members and may want to fulfil the expectations of others by attending. Solo physical activity may be more vulnerable to memory failure and goal reprioritisation, especially if it requires the mobilization of effort or more attractive alternatives are presented.

Intention elaboration is when an individual did not assume sufficient detail or the achievement of a series of actions and contextual opportunities to realise their intention. Despite the similar contribution of intention to behaviour in group and solo physical activity models, the elaboration required to engage in group and solo physical activities may have differed. Group physical activity may not be performed if an individual fails to be organised for the specific time of the meeting. Whereas solo physical activity may not require the same rigid scheduling and concordance with others as group physical activity and thus may appear easier to perform. Conversely, solo physical activity may not be performed as there are not others to offer reminders, provide information on how to get to the destination and what exercise equipment to bring. It is possible that the differences between group and solo physical activity in relation to intention activation and elaboration may be conflated or similar barriers contributed to both group and solo physical activity disengagement; further investigation may be useful to identify specific difficulties which may be useful in the development of interventions.

5.9.2 Difference in TPB component predictivity of group physical activity compared to solo

The second hypothesis predicted that the TPB constructs would be more predictive of intention and behaviour for group physical activities than solo. However, the only significant difference in parameters was perceived behavioural control (PBC), specifically the self-efficacy component, which made a significantly greater contribution to intention in the solo physical activity model than group. This suggests that greater self-efficacy or confidence in one's own ability to perform behaviour is required to promote an individual's intention to engage in solo physical activity than group.

While previous evidence supports the relationship between self-efficacy and both group physical activity (McAuley, 1992; Dzewaltowski, 1989) and solo (Chen, Chaung, Korivi & Wu, 2015; Pinto, Rabin & Dunsiger, 2009), one study directly compared group and solo physical activity conditions and found self-efficacy significantly predicted adherence to home-based exercise but not class-based (Oman & King, 1998). Oman and King (1998) suggest this is related to perceptions of the ease of adherence to solo physical activity which may be more flexible and convenient than group physical activity which in turn may foster positive efficacious cognitions. It is possible that the perception of more efficacious cognitions of solo physical activity than group contributed to the significant difference between models.

The current findings do not support Eves et al. (2003), who found PBC made similar contributions to team sports, dancing, cycling and walking suggesting there is not a clear difference between group and solo physical activities. However Eves et al. (2003) measured PBC with one item, and did not differentiate between self-efficacy and controllability.

No significant differences were found between the contribution of controllability to intention or behaviour between group and solo physical activity. Solo physical activity may be more flexible and does not require other's concordance therefore it is surprising that the contribution of controllability was not significantly greater in the solo physical activity model than the group. Alternatively the student population may not find the controllability of solo over group physical activity important when choosing to engage in physical activity.

It is possible that the stage of exercise engagement confounded the results. For example Ahmad, Shahar, Teng, Manaf, Sakian and Omar (2014) found the contribution of PBC declined to intention and slightly to behaviour over a 24 week group physical activity intervention. Conversely the contribution of PBC to intention increased over a 12 week solo physical activity intervention (Blanchard, 2008). However, neither study included separate measures of self-efficacy and controllability, but the findings may suggest that TPB construct contributions may change according to the stage of exercise engagement which may be different depending on group or solo physical activity contexts.

There was no significant difference in the contributions of attitude to intention between group and solo physical activity models. This does not support Eves et al.'s findings where cycling demonstrated poorer contributions of affective attitude to intention than group-based activities such as aerobics or team sports. However, in the current study both instrumental and affective attitude were significantly more positive for group physical activity than solo. This is supported by self-deterministic theory which suggests group physical activity provides intrinsic motivation through social engagement whereas solo physical activities may be performed to reach an extrinsic goal, such as weight loss or as transport. Activities which are related to intrinsic motivation rather than extrinsic tend to be more enjoyable (Hagger & Chatzisarantis, 2007).

As previously mentioned with controllability, the lack of significant difference between attitude contributions in group and solo physical activity models may be confounded by differing stages of exercise engagement experienced by participants. For example, although attitude became less predictive of intention over a 12-week group-based and 24-week solo-based physical activity intervention (Ahmad et al., 2014; Blanchard, 2008), the decline was greater for the solo physical activity condition (44.83%, Blanchard, 2008) than the group (4.35%, Ahmad et al., 2014).

There was no significant difference in the contribution of subjective norm to intention between group and solo physical activity models. This is a similar finding to Eves et al. (2003), who found no clear differences between different physical activities of the contribution of subjective norm to intention. This finding is surprising given the social nature of group physical activity; however this may be related to the pressuring form of social influence represented by subjective norms. Non-pressuring social influence (represented by PAS, discussed below) was related to intention to engage in group physical activity, which may suggest support and opportunities are more important in promoting group physical activity than the pressuring form of social influence including the perceived behaviour and beliefs of important others. Alternatively as previously mentioned the stage of exercise engagement may influence the contribution of subjective norms to intention. For example, subjective norm diminished through group and solo physical activity interventions, but declined more for the group physical activity intervention (87.1%, Ahmad et al., 2014) than the solo (29.17%, Blanchard, 2008). Any differences in the contribution of subjective norm between group and solo physical activity models may have been conflated due to not controlling potentially confounding effects of stages of exercise engagement.

5.9.3 Differences in TPB Models augmented by PAS and PAS predictivity of group physical activity compared to solo

The third hypothesis predicted that group physical activity would be better explained than solo when the TPB was augmented by PAS, as proposed by Chatzisarantis, Hagger and Brickell (2008) and the fourth predicted that PAS would make greater contributions to intention and physical activity behaviour in the group physical activity model than the solo. However the current data did not fit the augmented TPB model as specified by Chatzisarantis et al. (2008) for either the model overall, or for group and solo physical activity models separately. When the model was respecified guided by the inspection of MI, only the group physical activity model was significantly improved with the addition of PAS, which contributed significantly to intention. This addition significantly improved the amount of variance explained for intention to engage in group physical activity from the original group TPB model

(Model 1) by 3% ($\Delta F=12.18$, $p<0.01$), which is identical to the improvement found by Chatzisarantis et al. (2008) when PAS contributed to intention directly and indirectly through attitude.

Inspection of MI indicated that the solo physical activity model could not be improved by PAS contributing to any of the constructs within the TPB. This along with the non significant contribution of subjective norm on intention implies that both pressuring and non-pressuring forms of social influence are not important in the prediction of solo physical activity. Conner and Norman (2005) recommend that exercise interventions should target attitudes and perceived behavioural control but not subjective norms, as its contribution to intention and behaviour is minimal. However, while it is not an important construct in solo physical activity behaviour it did significantly contribute to intention to engage in group physical activity which suggests that it still may be an important construct to address in group-based physical activity interventions.

PAS was an important predictor of intention within the group physical activity model, which suggests non-pressuring social influence featuring the support and provision of opportunities may facilitate intention to engage in group physical activity. PAS's contribution to intention was highly similar to that found by Chatzisarantis et al. (2008), which suggests that Chatzisarantis et al. (2008) may have been measuring mostly group physical activity as part of Biddle, Goudas, and Page's (1994) leisure-time physical activity questionnaire, or alternatively group physical activity may consist of most leisure time-physical activity. However there was a significant contribution of subjective norm to intention to engage in group which was not found in Chatzisarantis et al.'s study. This may be related to the composition of the subjective norm construct, as Chatzisarantis et al. measured injunctive norms and the current study measured descriptive and injunctive norms. Okun, Karoly and Lutz (2002) found injunctive norms did not significantly predict leisure-time exercise while descriptive norms did. The authors suggest this is related to Reno, Cialdini, and Kallgren's (1993) findings that injunctive norms were more useful for decreasing antisocial behaviour and descriptive norms were more useful for increasing pro social behaviour. Okun et al., (2002) state that although exercise is not a pro social behaviour, it is a positive behaviour, therefore intention to engage in exercise may be more strongly influenced by descriptive than injunctive social norms, which may explain the discriminate findings of the current study and Chatzisarantis et al. This supports Ajzen's (2002) recommendation of including a descriptive norm component within the subjective norm construct especially when investigating physical activity behaviour. In support of Chatzisarantis et al. (2008)'s findings, the group physical activity model could not be improved by PAS directly contributing to physical activity behaviour. This suggests support, understanding and provision of social physical activity does not directly facilitate group physical activity behaviour and as explained previously, this may be related to unmeasured additional variables required to effectively predict group physical activity.

5.9.4 Strengths and limitations

This was the first study to compare group and solo physical activity using SEM and path analysis to compare contributions of parameters. Most studies measure leisure activity, more formal activity (such as sports training), or general exercise (Blue, 1995; Godin & Kok, 1996; Hagger, Chatzisarantis & Biddle, 2002); however comparisons between different types of activity are rare. Eves et al. (2003) compared multiple activities including team sports, aerobics, dancing, swimming, cycling and walking using the TPB, but did not specify if they were group or solo based. Therefore it was not possible to draw conclusions relating to the differences in group and solo physical activity within the TPB from their study to directly compare with the current findings. In addition, Eves et al. (2003) did not provide test differences in parameters using path analysis, therefore any observed differences cannot be assumed to be significant or not. The current study finds greater predicted variance of intention and behaviour of group physical activity than solo, and a significant difference in the contribution of self-efficacy to intention in group physical activity versus than solo which may be useful in the developing of physical activity interventions. For example, for individuals with low self-efficacy it may be more effective to promote group physical activity. However if the aim is to promote a solo physical activity, such as active transport then it is vital to enhance self-efficacy. Self-efficacy is the confidence in one's ability to perform a behaviour, controllability is one's perceived control over the behaviour (Armitage & Conner, 1999a, 1999b). According to the TPB (Ajzen, 2000) improving the antecedent of intention will in turn increase intention which increases engagement in the targeted behaviour.

A strength of the current study’s method was that it controlled for fatigue effects (by finding no significant differences between the four orders of the questionnaire) which were not a confound despite the length of the first questionnaire pack. In addition the study avoided the potential confound of participants misunderstanding definitions of moderate or vigorous intensity activity despite guidance (Canning, Brown, Jamnik, Salmon, Ardern & Kuk, 2014) as they were asked to detail their activity which was then coded by a research into a resultant MET score. This measure of physical activity is useful for direct comparison with other studies. However, a limitation with the self-report physical activity is that it is sensitive to inflation compared to an objective measured using an accelerometer (Troiano, Berrigan, Dodd, Masse, Tilert & McDowell, 2008) and vulnerable to socially desirable responding. To control for this, further investigation is required to detect any differences between the social desirability and over or underestimation of group and solo physical activity.

The majority of missing data related to the second part of the questionnaire that was completed two weeks after the first. Maximum likelihood was an appropriate method to handle the missing data as no significant differences were found between those who responded to the second questionnaire and those who did not. Nevertheless, a limitation of missing data was the inability to assess multivariate skewness and kurtosis using Mardia’s (1970) coefficient. Under conditions of non-normality, maximum likelihood results in relatively accurate parameter estimates (Mindrila, 2010) but may report inflated chi-square statistics which may suggest the rejection of a tenable model, and underestimated standard errors which may suggest the existence of stronger effects in the model than truly exist (Sharma, Durvasula, & Dillon, 1989). Both the original TPB model and the expanded version demonstrated non-significant chi-square statistics, which indicated acceptance of model fit. Newsom (2005) reported multivariate non-normality is infrequent in practice if individual variables are normally distributed. Univariate skewness and kurtosis was inspected and were acceptable, this along with the chi-square statistics suggest that it is unlikely that non-normality overly influenced the model analysis.

As previously mentioned, the study did not measure the participants' stage of exercise adoption, which may have confounded the results. Further research is required to identify the differences between group and solo physical activity and the change in TPB constructs through stages of exercise adoption to maintenance.

The sample was limited to university students, who may have more time and access to exercise facilities than full-time employed community samples and therefore findings cannot be generalised beyond the student population. However physical activity patterns may predict activity later in life and therefore it is important to understand and promote physical activity in young adults. The self-selecting sample may be biased to represent respondents interested in and with positive attitudes towards physical activity, which may not be generalisable to other students or the general population. However this bias may have been mitigated somewhat as an incentive was provided for completion of the study. This may have attracted participants who felt ambivalent or negative about physical activity.

MI were inspected to respecify the model augmented by PAS after that specified by Chatzisarantis et al. (2008) showed non-significant and unacceptable fit. This approach was exploratory, but supported one of Chatzisarantis et al.'s (2008) findings that PAS directly contributes to intention. In addition, as only one post hoc coefficient was added, this is within the limits of three recommended by Herting and Costner (2000). However further investigation is required to ensure that the direct contribution of PAS to group physical activity and not solo is stable, and not unique to this data.

Salient beliefs were not elicited to be used as specific questions within the TPB, instead generic items were used. This permitted group and solo physical activity to be adequately compared, as specific attitudinal, normative referents, and control factors may be different between group and solo physical activity models. In addition the purpose of this study was to compare the TPB between group and solo physical activity, not to test the theory or seek to increase the most available explained variance of intention or behaviour.

5.9.5 Implications

The only difference in TPB parameters was the contribution of self-efficacy to intention was significantly greater in solo physical activity than group. This suggests that there may be greater perceived barriers to solo physical activity, despite this being an attractive option which is accessible and easy to schedule for engaging in physical activity. McAuley, Courneya and Lettunich (1991) found that women demonstrated significantly poorer self-efficacy than men at the beginning of a 20 week group-based exercise intervention, however by the end of the intervention these differences dissipated. Further research is required to investigate if group or solo physical activity may be more successful in promoting adherence through changes in self-efficacy between men and women. If group physical activity is easier to achieve than solo, then this may help tailor the provision of NHS prescribed exercise programmes to include group physical activities which may promote adherence and psychological well-being. In addition, PAS was found to be an important contributor in promoting intention to engage in group physical activity. Therefore exercise promotion strategies would benefit from targeting both the individual and their partner or significant others to engage in physical activity or at least provide non-pressuring support.

5.9.6 Further studies

Interventions based on the theory of planned behaviour aim to manipulate attitudes, subjective norm or perceived behavioural control which in turn produce changes in intention and therefore behaviour (Ajzen, 2002). As self-efficacy was the greatest contributor of intention to engage in both group and solo physical activity models it should be the primary focus of an intervention based on the TPB. Ashford, Edmonds and French (2010) find the most successful techniques to improve exercise self-efficacy relate to those most easily achieved by the presence of others, including vicarious experiences (seeing others engage in the behaviour can raise the individuals belief that they can also master that activity, Bandura, 1977) and also the comparison of the individual's performance with the performance of others (Ashford et al., 2000). While this may be easier to achieve with a group of individuals, it may be possible to utilise technology to share solo exercise performance with others on the internet.

Ashford et al. (2000) also found a significant negative relationship between self-efficacy and verbal persuasion, and concluded that verbal persuasion alone was limited in increasing self-efficacy perceptions despite its inclusion in majority of studies included in the meta-analysis. Barrier identification and encouraging participants to identify solutions to overcoming these barriers was associated with lower self-efficacy. Ashford et al., (2000) suggest that this technique may be unhelpful at the motivational phase of behaviour change as the individual is required to rehearse the reasons why a behaviour would be difficult. However, self-efficacy may develop if the identification of barriers is used as a precursor to rehearsing what would necessary to successfully change a behaviour rather than the reasons why an individual cannot perform the behaviour. Therefore if motivation interviewing techniques were utilised, it is important to tailor the intervention based on the stage of exercise engagement.

It would be beneficial to compare the change in TPB components over time through exercise adoption to maintenance between group and solo physical activity. Interventions based on these findings could allow a tailored approach that addresses the needs of participants through the stages of exercise engagement. In addition, it would be useful to investigate if the differences in the TPB between group and solo physical activity models apply to other populations, especially if used to facilitate physical activity promotion strategies.

Further investigation into the function of PAS within group and solo physical activity models is required to confirm the findings based on the exploratory model involving the inspection of MI. Based on the current findings, it appears that an intervention designed to increase group physical activity would benefit from targeting PAS. It is possible to manipulate PAS through exercise instructor inter-personal style, which has found to be associated with improved intention and physical activity behaviour (Chatzisarantis & Hagger, 2007). In addition, it may be useful to incorporate an individual's family or important others in an intervention to help promote PAS from within the home.

It would be useful to conduct interviews or open ended questionnaires to identify why PAS did not directly contribute to engagement in group physical activity as found by Chatzisarantis et al. (2008). This may relate to the sample as Chatzisarantis et al.'s (2008) sample included school pupils, university students and working adults, whereas the current sample only included university students. It is possible that university students have to manage more goals (such as coursework and exams) than members of the general population of the same age, therefore group physical activity is reprioritised and not performed.

5.10 **Conclusion**

The group physical activity model explained greater variance of intention and physical activity behaviour than the solo physical activity model, suggesting other factors are involved in the prediction of solo physical activity. Self-efficacy was a more important predictor of intention to engage in solo physical activity than group. However, PAS made a significant contribution to intention to engage in group physical activity but did not contribute at all to constructs within the solo physical activity model. These may have an impact on the promotion of group and solo physical activity and highlights the importance of developing self-efficacy and non-pressuring social influence of important others.

Chapter 6

General Discussion

6.1 Introduction and the Critical Reflection of the PhD Journey

There were two main aims to this thesis. The first was to investigate the relationship between group and solo physical activity and psychological distress. The second was to understand the factors involved in this to potentially inform future interventions or policy in order to promote physical activity that can be more easily adhered to and enjoyed.

The relationship between psychological distress (including depression, stress and anxiety) and group and solo physical activity was first examined in a systematic review (Chapter 2), then investigated in a cross-sectional survey of both the general population and a student population (Chapter 3) and finally in an group versus solo quasi random jogging intervention (Chapter 4).

The cross-sectional study with the community sample was completed first. It was designed to investigate factors involved in group and solo physical activity but also to recruit participants for a future intervention study. Each of the council wards had public spaces that could be used for physical activity (such as playing fields or beaches). The intention was to facilitate physical activity groups in these wards, however almost none of the respondants indicated interest in taking part in one of these interventions, so the direction of the project had to be reconsidered.

The study was repeated with a student sample which resulted in a greater sample size and more interest in an intervention. The systematic review (Chapter 2) highlighted the need for higher quality studies comparing similar group and solo physical activity prescriptions. Therefore jogging was chosen as the duration, time and intensity between conditions could be made the same. JogScotland was able to include particpants in pre-existing jogging groups and to provide advice. However, recruitment was difficult and data collection had to include three data collection periods to ensure an adequate sample size. Interviews were planned to further understand participants' experience relating to benefits and barriers, however only six participants volunteered to take part. A better study design would have included a cross-over design where particpants would complete a period of group or solo physical activity and then swap to the other condition. Participants would then be able to contrast their experience of both conditions in structured interviews. This information may be useful to inform a higher quality measure addressing the benefits and barriers of group versus solo physical activity. It may also inform futher understanding into the mechanincs of how group physical activity may be more therapeutic than solo.

The second aim of this thesis was to investigate the factors involved in group and solo physical activity, with the implications that this information may be useful for futher interventions or promotion. The original basis for the investigation in the cross-sectional study was to examine if indivudals preferred group physical activity to solo, but encountered more barriers to engaging in this. Therefore, they might engage in solo but find it difficult to maintain. However the measure relating to preferences was limited and may have been resulted in more divergent responses if it had contained a greater variety of responses. The study did find that there were greater barriers to group physical activity than solo which suggests that more targeted support may be required when promoting this type of physical activity to new exercisers. The final study investigated the different factors related to participation in group and solo physical activity (without investigating the relationship with psychological distress) using the Theory of Planned Behaviour. Only one difference was found which related to self-efficacy. This may provide a basis for further investigation of the development of an intervention to promote group physical activity. The following sections reflect on the findings relating to each of the two overarching aims of the thesis.

6.2 The relationship between psychological distress (including depression, stress and anxiety) and group and solo physical activity

As described in Chapter 1, the physical and psychological health enhancing benefits of physical activity have been well established (US Department of Health & Human Services, 1996; Warburton, Nicol & Bredin, 2006). However it was unclear if group versus solo physical activity was more effective in the reduction of psychological distress. Burke et al. (2006) conducted a meta-analysis that compared the contexts of home-based programmes with and without contact, standard exercise classes, and/or true groups (defined as employing team building exercises to encourage cohesion) and the improvement in quality of life. Burke et al. (2006) found no differences between the collective and home-based with contact conditions, but did find the collective condition was superior to the home-based no contact condition, although differences were not significant. This provides some support that group physical activity may be superior to group, however the quality of life component included a variety of measures and did not provide a separate analysis of stress, anxiety or depression, when it was possible that these separate aspects may have interacted with group and solo physical activity contexts differently.

The systematic review (Chapter 2) provided some support that group physical activity may be superior to solo in the reduction of depression, however more high quality studies are required for confirmation. The systematic review found there were no significant differences in group versus solo physical activity and the reduction of anxiety, however as only three studies measured anxiety, this is inconclusive, but warrants further investigation. Likewise, there were insufficient studies to compare group versus solo physical activity and the effect on stress, further research is required to investigate this relationship. Nevertheless, no included study found solo physical activity superior to group in the reduction of any measure of psychological distress, and despite poor quality studies this implies that the social context of group physical activity is effective in addition to the physiological aspect of physical activity in reducing psychological distress.

However, as with Burke et al.'s (2006) meta-analysis, the majority of included studies were clinical and not directly related to the general population. It is important to promote physical activity to the general population as UK population engagement is poor, throughout the UK 61.5% of men 71.5% of women do not meet physical activity recommendations of an accumulation of 30 minutes or more of moderate-intensity physical activity five days per week, or 20 minutes of vigorous activity three days per week (The British Heart Foundation, 2012; Joint Health Surveys Unit, 2010; Scottish Health Executive, 2011; Welsh Government, 2011; Northern Ireland Statistics and Research Agency, 2007; Pate et al., 1995). Likewise, it is important to reduce psychological distress in the general population, as a large, broadly representational, non-clinical UK based study reported that approximately 20% of individuals experienced some form of stress (including mild to extremely severe as categorised by Lovibond and Lovibond, 1996); 18%, depression and 6%, anxiety (Crawford & Henry, 2003).

To further investigate the effectiveness of group physical activity in the reduction of psychological distress versus solo, a cross-sectional study was developed (Chapter 3) which examined depression, stress and anxiety separately in relation to group and solo physical activity in both the general population and a student population.

In both the student and community samples, higher levels of group physical activity were statistically significantly associated with lower levels of depression, anxiety and stress. In the community sample no correlation was found between solo physical activity and any aspect of psychological distress. There was a small, statistically significant correlation between increased anxiety and increased solo physical activity in the student sample. This is in conflict from review findings (e.g. Conn 2010a; Wipfli, Rethorst & Landers, 2009) which report that physical activity has an anxiolytic effect. Anxious participants may have motivated to engage in some sort of physical activity and sought out solitary activities. This implies that psychological distress may be best improved by group physical activity, and strategies should focus their promotion on engaging with a group. However, these findings were based on correlational design and therefore the influence of group versus solo physical activity could not be assumed, as an individual with increased psychological wellbeing may be more inclined to engage in group physical activity over solo and may also have more access to social support through greater support networks. Therefore, a 10-week intervention study was developed to compare the effects of a group and solo jogging programme on stress, depression and anxiety in university students (Chapter 4).

No significant differences were found in psychological distress between group and solo jogging conditions at any time point, but psychological distress increased significantly from baseline to week 10 for only those in the solo jogging condition. As the jogging intervention proceeded through the university calendar psychological distress may have been related to increasing demands of coursework and exams at the end of semester. Participation in the group jogging condition may have protected against an increase in the psychological distress to that experienced by those in the solo condition. This may be related to the greater quantity of jogging performed by those in the group condition versus the solo, or related to supportive aspects of the social context. Further studies investigating student physical activity behaviour throughout the academic year would benefit from no-exercise control group. A limitation was the low sample size; recruitment was difficult, especially of low or inactive participants and of participants exhibiting diverse measures of psychological distress. Further investigation would benefit from recruiting a larger sample of individuals either by expanding the recruitment period, employing more recruitment agents, including a measure of psychological well-being to investigate improvement in addition to the reduction of psychological distress (which may have been mild at baseline) or to sample individuals with higher levels of psychological distress.

These studies combined suggest that group physical activity may have greater scope in the reduction or protection of increased psychological distress than solo, however further support is required. Physical activity in general may improve psychological well-being beyond physiological methods by providing provides an opportunity to meet and be with others (Crone, 2007) and a meaningful opportunity for social interaction (Caret-Morris & Faulkners, 2003). The element of social interaction which was highlighted as one of the most important factors in Mason and Holt's (2012) review may moderate or mediate the relationship between physical activity and psychological distress. The authors reported that some participants reported that they attended simply to engage with others, rather than focusing on the physiological improving aspects of exercise. This may be especially true for participants in the cross-sectional studies, paticularly in the general population who may have less time for social opportunities.

An undocumented interview with a participant in the group jogging condition (Chapter 4) discussed how she had been able to change her identity and take the experience forward to engage in different kinds of activity. This anecdote is similar to a theme described by Mason and Holt (2012) where participants were able to change their identity through the vehicle of physical activity, and this may be related to the provision of an intrinsic sense of reward and achievement through purposive activity. Their review also highlighted the importance of a non-competitive and caring environment, which was provided in the intervention study by JogScotland and it may help to explain the positive adherence rates.

Both Mason and Holt’s (2012) review and the findings of the current thesis provide support that social interaction appears to have some interface with the facilitation of physical activity in the improvement of mental wellbeing. Therefore any further investigation into these mechanisms should include a specific focus on the area of social interaction, regardless of the population.

The implications of the current findings are that physical activity promotion may be better focused on group over solo physical activity for the reduction of depression, which may be especially important to exercise referral schemes or to help inform government policy. Exercise referral schemes (also known as "exercise on prescription") are an intervention involving local NHS health boards, general practices, community health partnerships, local authorities and voluntary and private leisure service providers (Jepson, Robertson & Roi, 2010). Each scheme may vary in the mode of prescription, including access to exercise classes or gym membership and are targeted to individuals with illness (such as diabetes, CHD or depression) or risk factors for future ill health (such as obesity). The findings of several reviews of the effectiveness of exercise referral schemes are ambiguous, however short term periods (of 12 weeks and less) appear to be effective in promoting physical activity

(NICE, 2006; Williams, Williams et al., 2007). The current findings suggest that individuals with depression would benefit from group physical activity, therefore it would be beneficial to promote group based classes or groups through the exercise referral scheme to these individuals. Those referred may benefit from general practitioners and other referrers from assistance or encouragement to overcome barriers to group engagement.

6.3 **Factors involved in group versus solo physical activity participation**

Due to poor engagement with physical activity guidelines, it is important to investigate factors involved in participation, for example, Trost et al.'s (2002) extensive systematic review found age, being male, barriers to physical activity, lack of time, mood disturbance, climate/season and perceived effort were the most consistent inverse correlates of physical activity engagement. Furthermore, it is important to investigate factors involved in participation of group versus solo physical activity due to the implications associated with psychological distress. In addition it is important to investigate factors relating to participation or non-participation in inactive or low active individuals, to further develop promotion or intervention strategies. However the current evidence relating to adherence is ambiguous and of poor quality. Burke et al. (2006) directly compared adherence between group and solo physical activity contexts but found no significant differences between collective and home-based contexts in promoting physical activity adherence. Burke et al. (2006) related this to similar amounts of contact received by all participants by physical activity staff and researchers. In addition Burke et al. (2006) suggested these findings were related to the definition of adherence as group attendance was more likely to be objectively measured where solo physical activity was more likely to be subjectively reported, resulting in bias. Earlier evidence from a review of sixteen systematic reviews suggest that interventions promote longer-term change if they incorporate regular contact with an exercise specialist (Hillsdon, Foster, Cavill, Crombie, & Naidoo, 2005) which suggests a social component. However only four of these reviews considered a group and solo physical activity contexts and presented ambiguous findings. Both these pieces of evidence indicate that further research is required to evaluate if and how group versus solo physical activity settings are more beneficial for adherence.

The intervention study (Chapter 4) was developed to eliminate some of the bias found in the studies in the systematic review (Chapter 2) and wider literature. The same prescription of jogging was provided to participants, contact with the researcher was kept to a minimum as printed documentation prompted participants to complete online questionnaires at specific time points. Those assigned to the group jogging condition completed (non-significantly) more jogging overall than those assigned to the solo condition, which this was due to jogging at additional times alone to the group. This may suggest that the group motivated participants to engage in the same physical activity alone. In addition, those assigned to the group condition engaged in more moderate intensity activity than those in the solo condition, excluding all jogging activity. Therefore participation in a group physical activity may have wider effects beyond that of the intervention, and therefore future studies would benefit from including a general measure of physical activity outwith the prescribed activity. Although this finding requires further replication, it may suggest that group physical activity may have greater benefits beyond the measures included in a study, and may lead to further engagement with physical activity in general.

6.3.1 Preferences for Group or Solo Physical Activity

The cross-sectional study (Chapter 3) compared preferences of group versus solo physical activity between low, moderate and highly active participants. Assumptions of chi-square were violated and thus results relating to significance could not be reported, however a greater number of moderately and highly active participants expressed preferences for group over solo, and a similar number of low active participants expressed preferences for group and solo. There was not a significant difference between physical activity level and preference for group and solo physical activity in the student sample. However, preference for group and solo physical activity was similar for participants who were moderately and highly active, over half of low active individuals preferred solo physical activity. This tentatively suggests that low active individuals may prefer solo physical activity over group.

This may be related to greater perceived barriers associated with group physical activity versus solo such as inflexible scheduling due to the concordance of others. If low active individuals prefer solo physical activity, but group is associated with potentially increased adherence and psychological well-being, low active individuals may not maintain their physical activity long enough to experience the benefits. Preference may also be influenced by age, with older adults preferring solo physical activity (King, Rejeski, & Buchner, 1998) and younger adults preferring group physical activity over solo (Burke, Carron & Eys, 2006). Younger adults may view group exercise as an opportunity for socialising. Older adults may be wary of their physical limitations and may be concerned that they would be unable to keep up with a group.

6.3.2 Benefits and barriers

The cross-sectional study (Chapter 3) compared benefits and barriers of group versus solo physical activity across different physical activity levels. In the community sample there were no significant differences between benefits of group and solo physical activity for participants of all activity levels. In the student sample only highly active participants perceived greater benefits associated with solo physical activity over group. Highly active students may not be able to schedule all of their physical activity needs around others, and thus may prefer solo physical activity due to increased flexibility compared with group. In both student and community samples, participants of all activity levels perceived significantly greater barriers to group physical activity than solo. The implications of these findings suggest that low active individuals may be less inclined to engage in group physical activity than solo, which may be more beneficial for their psychological health and potentially lead to greater adherence. Solo physical activity may be perceived as incurring less barriers as there is flexibility in organisation and choice of activity; however it may require additional motivation or self-efficacy than group. However this is speculation based on cross-sectional findings and needs further investigation. Further studies may benefit from qualitative data collection methods to access benefits and barriers perhaps not identified from the measure developed in Chapter 3. Also, investigating the change of these as individuals begin a physical activity behaviour and maintain it may be useful in developing programmes or strategies in the future.

The final study (Chapter 5) compared group and solo physical activity models using the theory of planned behaviour. The TPB is a complete model designed to explain behaviour. Comparing group and solo physical activity models provided an insight into which factors predict group and solo physical activity differently. This provided a greater understanding of participants beyond benefit and barriers to group and solo physical activity.

Overall, these combined findings suggest that low active individuals, even those who have a greater preference for group physical activity may not engage with group physical activity due to greater perceived barriers than that of solo despite the psychological benefit. In addition, engaging in group physical activity may be easier to maintain over time leading to better adherence. These findings have a direct implication for the Scottish strategy "Let's Make Scotland More Active" (Physical Activity Task Force, 2002), which was developed to achieve improvements in physical activity so 50% of all adults in Scotland aged over 16 and 80% of all children aged 16 and under will meet the minimum recommended levels of physical activity (to accumulate at least 30 minutes of moderate physical activity on at least five days of the week, Pate et al., 1995) by 2022. The current findings relate directly to strategic objective, "to develop and maintain long-lasting, high-quality physical activity environments to support inactive people to become active". If group physical activity is more beneficial to promoting long-term adherence and requires less self-efficacy than solo physical activity despite the perceived barriers, then future studies should identify additional barriers and investigate how to help individuals or tailor the environment so they can be overcome.

6.4 **Future studies**

The systematic review could not provide an insight into the effectiveness of group versus solo physical activity and the effect on anxiety or stress. Cross-sectional evidence suggested group but not solo physical activity was associated with reduced stress and anxiety. Participants allocated to the group condition may have been protected against increased psychological distress as experienced by those in the solo physical activity condition. Therefore, further investigation is required to explore the relationship between reduced anxiety and stress and group versus solo physical activity, especially if stress moderates or mediates depression, as group physical activity may offer protection if not improvement in psychological distress. It may be beneficial to include a measure of psychological well-being in addition to psychological distress, as psychological distress levels may already be low and not demonstrate much change throughout the intervention.

Future studies would ideally include inactive or low active individuals and compare two identical group and solo physical activity prescriptions involving activity that can be conducted outside of a research intervention (to promote engagement after the intervention). Random allocation is essential for maintaining high quality studies but may lead to attrition if participants are allocated to an unfavourable condition. It may be easier for participants assigned to a solo condition to remain in the study while engaging in little physical activity, whereas there may be greater barriers encountered by an individual who wishes to return to a group based physical activity having not attended several consecutive weeks. The studies in this thesis were conducted before the ubiquity of smart phones and affordable technology was available to track physical activity. In-built tri-axial accelerometer and gyroscope on smartphones have demonstrated high accuracy on physical activities including sitting, standing, walking, and jogging (Wu et al., 2012; Yi & Ye, 2013). Future studies would benefit from the use of this technology and applications to provide objective measures of both group and solo physical activity level, eliminating the comparison of self-report versus attendance based measures of adherence.

The measure described in chapter four to address benefits and barriers to group versus solo physical activity was limited in its development and may benefit from additional items and testing. Future studies should further investigate additional barriers to group physical activity especially in inactive or low active individuals, which may involve identifying specific issues for certain groups. For example, the general population and university students may perceive access to facilities and groups differently as university students have access to a large variety of clubs, societies and facilities. Qualitative methods such as interviewing or focus groups may collect more items than quantitative, but may be subject to researcher bias or demand characteristics. Identified barriers may then be reduced by improving the environment, such as ensuring there are facilities such as toilets for jogging groups or by working with individuals to create goals and if-then plans (Gollwitzer, 1999).

An alternate method of developing interventions may be based on the Theory of Planned Behaviour (Chapter 5), however this would require further investigation focusing on inactive or low active individual which may pose challenges such as recruiting sufficient participants required for structural equation modelling techniques. In addition interventions may be successful incorporating self-deterministic theory (SDT, Ryan et al., 2009). The final study (Chapter 5) indicated that intention to engage in group physical activity could be improved with perceived autonomous support. This may be further improved ensuring perceptions of competence (a desire to interact effectively within the environment), and relatedness (a desire to feel connected to others), through physical activity leaders, either directly or creating a supportive culture within the group.

6.5 **Conclusion**

This thesis found some support from the literature for group versus solo physical activity in the reduction of depression, but found that there was not sufficient evidence to establish the effectiveness in relation to stress and anxiety. Cross-sectional studies provided some evidence for the relationship between depression, stress and anxiety and group physical activity, but this could not be supported in the intervention jogging study. Further evidence is required to investigation the relationship between group and solo physical activity and the therapeutic effect on stress, depression and anxiety when individuals are undergoing a potentially stressful period of time.

Group and solo physical activity benefits and barriers have not been assessed quantitatively before; this thesis found that individuals perceived greater barriers to group versus solo physical activity. This may provide some insight into understanding why individuals may chose solo physical activity over group, despite greater potential benefits associated with group. This thesis also provides support that group and solo physical activity may be predicted differently using the Theory of Planned Behaviour, and that self-efficacy may be more important in predicting intention to engage in solo physical activity than group activity.

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Appendix A Additional Tables

A1 Summary of Literature Sources and Number of Identified Studies

	Search Term	Hits Per Database						
		AMED	CINAHL	EMBASE	PsycINFO	SportDISCUS	WOK	Total Hits Combined
	Physical Activity AND Group AND Solo AND Psychological Distress	181	498	1,881	352	808	12,097	15,817
	Psychological Distress (10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38)	46,517	329,296	2,404,672	619,256	103,426	9,183,731	12,686,898
	Solo (5 OR 6 OR 7 OR 8 OR 9)	13,958	139,696	704,843	201,980	70,572	3,870,540	5,001,589
	Group (3 OR 4)	22,387	174,270	2,153,093	256,123	95,554	8,473,372	11,174,799
	Physical Activity (1 OR 2)	17,970	88,259	316,362	29,150	178,884	1,520,948	2,151,573
1	Exercise	17,165	72,758	267,216	20,660	162,643	962,158	1,502,600
2	physical activity	2,331	23,392	76,252	11,017	33,810	680,480	827,282
3	Supervised	507	2,333	11,800	2,863	1,086	49,669	68,258
4	Group	22,117	172,651	2,144,677	253,798	94,895	8,434,456	11,122,594
5	Home	6,794	87,362	195,197	48,515	23,079	542,648	903,595
6	Unsupervised	61	409	4,383	929	168	24,549	30,499
7	Solo	26	409	2,858	671	1,712	13,331	19,007
8	Solitary	77	1,277	37,183	2,066	286	129,734	170,623
9	Individual	7,381	53,233	474,660	154,244	46,431	3,220,040	3,955,989
10	depress$	5,684	67,765	408,773	145,209	10,188	1,360,315	1,997,934
11	dysthym$	22	536	5,806	2,674	49	8,646	17,733
12	Sad	65	816	8,860	3,908	642	19,241	33,532
13	Sadness	107	917	2,944	3,909	207	8,286	16,370

Search Term		Hits per database						
		AMED	CINAHL	EMBASE	PsycINFO	SportDISCUS	WOK	Total Hits Combined
14	Bipolar	239	7,022	55,139	19,138	1,289	190,081	272,908
15	bi-polar	2	27	128	81	21	2,923	3,182
16	Mania	40	898	13,861	5,430	380	27,423	48,032
17	Manic	49	623	15,022	5,569	260	29,328	50,851
18	cyclothymi$	2	65	958	463	6	2,272	3,766
19	Unipolar	24	938	8,405	3,844	500	31,896	45,607
20	uni-polar	0	0	12	4	1	696	713
21	Hopeless	24	262	1,205	477	53	2,898	4,919

22	Hopelessness	104	1,256	3,455	3,320	110	7,586	15,831
23	anxiou$	201	2,021	11,597	9,730	759	31,152	55,460
24	Anxiety	3,438	32,848	162,615	84,496	10,005	378,998	672,400
25	Angst	34	105	1,731	230	173	1,641	3,914
26	Worry	110	2,081	5,423	4,093	1,135	28,846	41,688
27	Worried	45	894	2,382	1,076	384	28,846	33,627
28	stress$	8,992	81,900	609,824	115,436	36,110	2,473,691	3,325,953
29	Mood	1,236	8,742	66,819	36,222	4,100	159,026	276,145
30	mood disorder	41	639	21,222	2,578	361	92,325	117,166
31	affect$	11,007	96,706	1,144,025	206,487	36,547	4,524,218	6,018,990
32	distress$	2,047	21,311	104,010	33,388	2,201	247,165	410,122
33	emotion$	4,937	35,905	143,228	128,424	13,198	347,179	672,871
34	psychological status	91	611	1,842	598	146	61,932	65,220
35	mental health	3,936	57,648	177,920	74,691	7,268	388,321	709,784
36	Wellbeing	327	2,475	27,152	31,574	561	12,826	74,915
37	well being	18,338	17,883	40,331	31,574	4,791	97,416	210,333
38	well-being	18,338	17,380	40,331	2,594	4,526	478,770	561,939

A2 Critical Constructs for Rating Studies for Bias

1 – Randomisation

Well covered	Described sufficiently well to determine satisfactory randomisation using appropriate method. Includes computer generated random numbers.
Adequately addressed	Reasonably clear that appropriate randomisation method was used. May be described as “randomly described” but with little explanation of method, therefore unable to fully determine satisfactory randomisation method. Includes randomisation which involves hand shuffling rather than computer generated.
Poorly addressed	Not adequately randomised using appropriate method.
Not addressed	
Not reported	

2 - Measure of psychological distress

Well covered	Highly robust measures (E.g. good validity and psychometrics) reported pre and post intervention (i.e. psychological distress measured only at baseline is not acceptable)
Adequately addressed	Acceptable measures reported pre and post intervention.
Poorly addressed	Poorly robust measures (E.g. Single item question)
Not reported	Measured, but no description to identify scales.

3 – Blinding - Those Involved in Assessment/Scoring/Analysis of Data Were Blind To Participant’s Condition

Well covered	Described sufficiently well to determine blinding conducted appropriately at assessment, scoring and analysis.
Adequately addressed	Reasonably clear that appropriate blinding was conducted at one or two of the following; assessment, scoring or analysis.
Poorly addressed	Unclear from description if blinding was conducted appropriately
Not addressed	No blinding used
Not reported	No mention of blinding
Not applicable	

4 – Programme - Any elements of programme other than physical activity are matched well between groups (e.g. Group CHD rehab programme might provide dietary counselling, this may or may not be available to solo participants)

Well covered	No additional intervention provided (just physical activity), or any additional intervention/programme was sufficiently alike between conditions.
Adequately addressed	Programme/Additional Intervention somewhat alike between conditions.
Poorly addressed	Programme/Additional Interventionpoorly alike between conditions.
Not addressed	No description of programme/Intervention, not same for both conditions.
Not reported	
Not applicable	

5 - Similar degree of prescribed physical activity between conditions

Well covered	Prescribed physical activity is sufficiently alike on all 3 elements including duration, frequency and type of activity, between conditions.
Adequately addressed	Prescribed physical activity is sufficiently alike on 2 out of 3 elements including duration, frequency and type of activity, between conditions.
Poorly addressed	Prescribed physical activity is sufficiently alike on 1 out of 3 elements including duration, frequency and type of activity, between conditions.
Not addressed	Prescribed physical activity is dissimilar between conditions.
Not reported	
Not applicable	

6 - Treatment adherence

Well covered	Described sufficiently well to determine treatment adherence sufficiently alike for both conditions.
Adequately addressed	Treatment adherence is somewhat alike between conditions. (If within 75%, AA)
Poorly addressed	Treatment adherence poorly alike between conditions.
Not addressed	Treatment adherence dissimilar between conditions.
Not reported	Measured, but not described
Not applicable	

7 – Similar psychological distress at baseline

Well covered	Described sufficiently well to determine psychological distress is sufficiently alike between conditions and within 0.5 standard deviations, or suitably controlled.
Adequately addressed	Baseline Psych distress somewhat alike between conditions and within 1 standard deviation.
Poorly addressed	Limited description (e.g. no sig diffs between groups), poorly alike at baseline, within 2 standard deviations.
Not addressed	Psych distress measures significantly different at baseline.
Not reported	
Not applicable	

8 – Sample size

Well covered	Sample size more than adequate for all conditions including at least 64 participants per condition (based on probability of 0.05, power 0.8 and anticipated effect size, Cohen's d, 0.5)
Adequately addressed	Sample size adequate for all conditions including at least 51 participants per condition, (based on probability of 0.05, power 0.7 and anticipated effect size, Cohen's d, 0.5)
Poorly addressed	Sample size not adequate, less than 51 participants per condition (power < 0.7)
Not addressed	
Not reported	
Not applicable	

9 - Acceptable and comparable attrition rate between groups

Well covered	Described sufficiently well to determine attrition is sufficiently alike between conditions (within 10% of each other and less than 20%)
Adequately addressed	Somewhat alike between conditions
Poorly addressed	Poorly alike between conditions
Not addressed	Significantly different between conditions.
Not reported	Not described
Not applicable	

10 - Adequate Follow-Up

Well covered	Described sufficiently well to determine sufficient and appropriate follow-up after the end of intervention. At least 6 months **post end of intervention**. Follow-up data must include psychological distress measures.
Adequately addressed	Adequate follow-up. At least 3 months **post end of intervention**. Follow-up data must include psychological distress measures.
Poorly addressed	Follow-up inadequate. Less than 3 months **post end of intervention**. Follow-up data must include psychological distress measures.
Not addressed	No follow-up.
Not reported	
Not applicable	

11 - Appropriate Analysis

Well covered	Described sufficiently well to determine if ITT or ML conducted appropriately (only robust if missing values are missing at random). For studies which report 100% completion rates, no need for missing data approaches, therefore WC.
Adequately addressed	Reasonably clear that appropriate analysis was conducted
Poorly addressed	Unclear from description if analysis conducted appropriately
Not addressed	No ITT/ML analysis used
Not reported	
Not applicable	

12 - Similar degree of frequency of contact (including face-to-face and phone contact from research staff and physical activity instructors) of solo to group physical activity condition

Well covered	Face-to-face and phone contact with physical activity instructor for solo physical activity conditions was at least 50% of group physical activity contact
Adequately addressed	Face-to-face and phone contact with physical activity instructor for solo physical activity conditions was at least 25% of group physical activity contact
Poorly addressed	Face-to-face and phone contact with physical activity instructor for solo physical activity conditions was less than 24.5% of group physical activity contact
Not addressed	Contact not available or controlled for, no contact for solo condition.
Not reported	Contact not reported

A3 Reasons for Exclusion

Study	Reason For Exclusion
Espnes, G. A. (1997). Exercise training in cardiac rehabilitation (CR): the effect from post	Inappropriate study design
McAuley, E., Blissmer, B., Marquez, D. X., Jerome, G. J., Kramer, A. F., & Katula, J. (2000). Social relations, physical activity, and well	Inappropriate study design
Karapolat, H., Akkoc, Y., Sari, I., Eyigor, S., Akar, S., Kirazli, Y., & Akkoc, N. (2008). Comparison of group-based exercise versus home-based exercise in patients with ankylosing spondylitis: effects on Bath Ankylosing Spondylitis Indices, quality of life and depression. Clinical Rheumatology, 27(6), 695–700. doi:10.1007/s10067-007-0765-0	Prescription different for each participant per condition
Karapolat, H., Demir, E., Bozkaya, Y. T., Eyigor, S., Nalbantgil, S., Durmaz, B., & Zoghi, M. (2009). Comparison of hospital-based versus home-based exercise training in patients with heart failure: effects on functional capacity, quality of life, psychological symptoms, and hemodynamic parameters. Clinical Research in Cardiology: Official Journal of the German Cardiac Society, 98(10), 635–642. doi:10.1007/s00392-009-0049-6	Prescription different for each participant per condition
Karapolat, H., Eyigör, S., Zoghi, M., Yagdi, T., Nalbangil, S., & Durmaz, B. (2007). Comparison of hospital-supervised exercise versus home-based exercise in patients after orthotopic heart transplantation: effects on functional capacity, quality of life, and psychological symptoms. Transplantation Proceedings, 39(5), 1586–1588. doi:10.1016/j.transproceed.2007.01.079	Prescription different for each participant per condition
Koldaş Doğan, S., Sonel Tur, B., Kurtaiş, Y., & Atay, M. B. (2008). Comparison of three different approaches in the treatment of chronic low back pain. Clinical Rheumatology, 27(7), 873–881. doi:10.1007/s10067-007-0815-7	No contact with author, unable to determine if exercise was in a group or supervised

Study	Reason For Exclusion
Kugler, J., Dimsdale, J. E., Hartley, L. H., & Sherwood, J. (1990). Hospital supervised vs home exercise in cardiac rehabilitation: effects on aerobic fitness, anxiety, and depression. Archives of Physical Medicine and Rehabilitation, 71(5), 322–325.	No contact with author, unable to determine if exercise was in a group or supervised
Oncu, J., Durmaz, B., & Karapolat, H. (2009). Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with post-polio syndrome. Clinical Rehabilitation, 23(2), 155–163. doi:10.1177/0269215508098893	No contact with author, unable to determine if exercise was in a group or supervised / Physical activity prescription appeared different per participant per condition
Soegaard, R., Christensen, F. B., Lauerberg, I., Lauersen, I., & Bünger, C. E. (2006). Lumbar spinal fusion patients' demands to the primary health sector: evaluation of three rehabilitation protocols. A prospective randomized study. European Spine Journal: Official Publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society, 15(5), 648–656. doi:10.1007/s00586-005-0884-8	No contact with author, unable to determine if exercise was in a group or supervised/ Physical activity prescription appeared different per participant per condition
Baskett, J. J., Broad, J. B., Reekie, G., Hocking, C., & Green, G. (1999). Shared responsibility for ongoing rehabilitation: a new approach to home-based therapy after stroke. Clinical Rehabilitation, 13(1), 23–33.	No contact with author/ Physical Activity Prescription per each participant per condition not identical

Study	Reason For Exclusion
Craft, L. L., Freund, K. M., Culpepper, L., & Perna, F. M. (2007). Intervention study of exercise for depressive symptoms in women. Journal of Women's Health (2002), 16(10), 1499–1509. doi:10.1089/jwh.2007.0483	No measure of psychological distress immediately post intervention
Patti, F., Ciancio, M. R., Reggio, E., Lopes, R., Palermo, F., Cacopardo, M., & Reggio, A. (2002). The impact of outpatient rehabilitation on quality of life in multiple sclerosis. Journal of Neurology, 249(8), 1027–1033. doi:10.1007/s00415-002-0778-1	No measure of psychological distress immediately post intervention
Fattirolli, F., Cartei, A., Burgisser, C., Mottino, G., Del Lungo, F., Oldridge, N., … Marchionni, N. (1998). Aims, design and enrollment rate of the Cardiac Rehabilitation in Advanced Age (CR-AGE) randomized, controlled trial. Aging (Milan, Italy), 10(5), 368–376.	No measure of psychological distress
Lamb, S. E., Pepper, J., Lall, R., Jørstad-Stein, E. C., Clark, M. D., Hill, L., & Fereday-Smith, J. (2009). Group treatments for sensitive health care problems: a randomised controlled trial of group versus individual physiotherapy sessions for female urinary incontinence. BMC Women's Health, 9, 26. doi:10.1186/1472-6874-9-26	No measure of psychological distress
Cagliyan, A., Kotevoglu, N., Onal, T., Tekkus, B., & Kuran, B. (2007). Does group exercise programme add anything more to patients with ankylosing spondylitis? Journal of Back and Musculoskeletal Rehabilitation, 20(2), 79–85.	Prescribed group and solo physical activity volumes not within 20% of each other
Erdman, R. A. M., & Duivenvoorden, H. J. (1983). Psychologic Evaluation of a Cardiac Rehabilitation Programme: A Randomized Clinical Trial in Patients with Myocardial Infarction. Journal of Cardiac Rehabilitation October 20, 3(10), 704–710.	Prescribed group and solo physical activity volumes not within 20% of each other
Eyigor, S., Karapolat, H., Yesil, H., Uslu, R., & Durmaz, B. (2010). Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. European Journal of Physical and Rehabilitation Medicine, 46(4), 481–487.	Prescribed group and solo physical activity volumes not within 20% of each other
Filiz, M., Cakmak, A., & Ozcan, E. (2005). The effectiveness of	Prescribed group

Study	Reason For Exclusion
exercise programmes after lumbar disc surgery: a randomized controlled study. Clinical Rehabilitation, 19(1), 4–11.	and solo physical activity volumes not within 20% of each other
Frost, H., Klaber Moffett, J. A., Moser, J. S., & Fairbank, J. C. (1995). Randomised controlled trial for evaluation of fitness programme for patients with chronic low back pain. BMJ (Clinical Research Ed.), 310(6973), 151–154.	Prescribed group and solo physical activity volumes not within 20% of each other
Güell, M. R., de Lucas, P., Gáldiz, J. B., Montemayor, T., Rodríguez González-Moro, J. M., Gorostiza, A., … Guyatt, G. (2008). Home vs hospital-based pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: a Spanish multicenter trial. Archivos de bronconeumología, 44(10), 512–518.	Prescribed group and solo physical activity volumes not within 20% of each other
Helbostad, J. L., Sletvold, O., & Moe-Nilssen, R. (2004). Home training with and without additional group training in physically frail old people living at home: effect on health-related quality of life and ambulation. Clinical Rehabilitation, 18(5), 498–508.	Prescribed group and solo physical activity volumes not within 20% of each other
Imfeld, S., Singer, L., Degischer, S., Aschwanden, M., Thalhammer, C., Labs, K.-H., & Jaeger, K. A. (2006). Quality of life improvement after hospital- based rehabilitation or home-based physical training in intermittent claudication. VASA. Zeitschrift Für Gefässkrankheiten, 35(3), 178–184. doi:10.1024/0301-1526.35.3.178	Prescribed group and solo physical activity volumes not within 20% of each other
Kääpä, E. H., Frantsi, K., Sarna, S., & Malmivaara, A. (2006). Multidisciplinary group rehabilitation versus individual physiotherapy for chronic nonspecific low back pain: a randomized trial. Spine, 31(4), 371–376. doi:10.1097/01.brs.0000200104.90759.8c	Prescribed group and solo physical activity volumes not within 20% of each other
Pinto, B. M., Marcus, B. H., Patterson, R. B., Roberts, M., Colucci, A., & Braun, C. (1997). On-Site Versus Home Exercise Programmes: Psychological Benefits for Individuals With Arterial Claudication. Journal of Aging & Physical Activity, 5(4), 311.	Prescribed group and solo physical activity volumes not within 20% of each other
Ramsay, C., Moreland, J., Ho, M., Joyce, S., Walker, S., & Pullar, T. (2000). An observer-blinded comparison of supervised and	Prescribed group and solo physical

Study	Reason For Exclusion
unsupervised aerobic exercise regimens in fibromyalgia. Rheumatology (Oxford, England), 39(5), 501–505.	activity volumes not within 20% of each other
Roche, G., Ponthieux, A., Parot-Shinkel, E., Jousset, N., Bontoux, L., Dubus, V., … Fanello, S. (2007). Comparison of a functional restoration programme with active individual physical therapy for patients with chronic low back pain: a randomized controlled trial. Archives of Physical Medicine and Rehabilitation, 88(10), 1229–1235. doi:10.1016/j.apmr.2007.07.014	Prescribed group and solo physical activity volumes not within 20% of each other
Smith, K. M., Arthur, H. M., McKelvie, R. S., & Kodis, J. (2004). Differences in sustainability of exercise and health-related quality of life outcomes following home or hospital-based cardiac rehabilitation. European Journal of Cardiovascular Prevention and Rehabilitation: Official Journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology, 11(4), 313–319.	Prescribed group and solo physical activity volumes not within 20% of each other
Yu, Yu, D. S. F., Lee, D. T. F., Woo, J., & Hui, E. (2007). Non-pharmacological interventions in older people with heart failure: effects of exercise training and relaxation therapy. Gerontology, 53(2), 74–81. doi:10.1159/000096427	Physical activity not of moderate or vigorous intensity
Cadmus, L. A., Salovey, P., Yu, H., Chung, G., Kasl, S., & Irwin, M. L. (2009). Exercise and quality of life during and after treatment for breast cancer: results of two randomized controlled trials. Psycho-Oncology, 18(4), 343–352. doi:10.1002/pon.1525	Samples were not the same for group and solo physical activity conditions

A4 Included Studies Physical Activity Volumes

Study Author	Group Physical Activity				Solo Physical Activity				Percentage of Group Physical Activity of Solo (%)
	Frequency (Per Week)	**Session Duration** (Mins)	**Intervention Length** (Weeks)	Total Volume (Mins)	**Frequency** (Per Week)	**Session Duration** (Mins)	**Intervention Length** (Weeks)	Total Volume (Mins)	
Analay et al. (2003)	3	50-65	6	1035	3	50-65	6	1035	100
Atousa (2009)	2	90	10	1800	2	90	10	1800	100
Blumenthal et al. (2007)	3	45	16	2160	3	45	16	2160	100
Bravo et al. (1996)	3	60	48	8640	3	60	48	8640	100
Cakit et al. (2010)	2	35	8	560	2	35	8	560	100
Cecchi et al. (2009)	2	60	12	1440	2	60	12	1440	100
Evcik et al. (2008)	3	60	5	900	3	60	5	900	100
Giallauria et al. (2006)	3	30	8	720	3	30	8	720	100
Hsieh et al. (2009)	3	60	8	1440	3	60	8	1440	100
King, Taylor, & Haskell (1993)	3	60	48	8640	3	60	48	8640	100
King et al. (2002)	3 (Week 1-24) 1 (Week 25-48) 0 (Week 49-72)	75	72	After 48 weeks: 7200	1	180	72	After 48 weeks: 8640	120

Study Author	Group Physical Activity				Solo Physical Activity				Percentage of Group Physical Activity of Solo (%)
	Frequency (Per Week)	**Session Duration** (Mins)	**Intervention Length** (Weeks)	Total Volume (Mins)	**Frequency** (Per Week)	**Session Duration** (Mins)	**Intervention Length** (Weeks)	Total Volume (Mins)	
McGale, McArdle, & Gaffney (2011)	2	55	10	1100	2	55	10	1100	100
Neuberger et al. (2007)	3	60	12	2160	3	60	12	2160	100
Reeder et al. (2008)	3	60	12	2160	3	60	12	2160	100
Regensteiner et al. (1997)	3	35-50	12	1530	3	35-50	12	1530	100
Solak et al. (2008)	5	35	3	525	5	40	3	600	87.5
Timonen et al. (2002)	2	90	10	1800	2	90	10	1800	100
Wu et al. (2010)	3	60	15	2700	3	60	15	2700	100
Yilmaz et al. (2003)	3	40	8	960	3	40	8	960	100

A5 Alternate Physical Activity Measures and Reasons for Exclusions

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
1	The Aerobics Center Longitudinal Study Physical Activity Questionnaire	Kohl, Blair, Paffenbarger, Macera, Kronenfeld (1988) [US]	Leisure & Household	18	Self-Admin by mail	Past 3 months	General	Limited to Leisure and Occupational; Too long recall
2	Baecke Questionnaire of Habitual Physical Activity	Baecke, Burema, Frijters (1982) [US]	Leisure & Occupational	16	Self-Admin	Usual Activity - No specified time component	General	Limited to Leisure and Occupational
3	Bouchard Three-Day Physical Activity Record	Bouchard, Tremlay, LeBlanc, Lortie, Savard, Theriault (1983) [Canada]	Leisure & Occupational	detail / table	Self-Admin & Instruction provided by interviewer	3 Days (2 week days, 1 weekend day)	General	Limited to Leisure and Occupational
4	CARDIA Physical Activity History	Jacobs, Hahn, Haskell, Piris, Sidney (1989) [US]	Leisure, Occupational & Household	55	Interviewer-admin in person or by telephone	Past 12 Months	General	Interviewer Assessed
5	Framingham Physical Activity Index	Kannel and Sorlie (1979), Framingham Heart Study [US]	Leisure & Occupational	18	Interviewer-admin	Usual Activity over 24hrs	General	Interviewer Assessed
6	Godin Leisure-Time Exercise Questionnaire	Godin and Shepard (1985) [Canada]	Leisure	4	Self-Admin	Usual Activity - No specified time component	General	Limited to Leisure Activity

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
7	Health Insurance Plan of New York (HIP) Activity Questionnaire	Shapiro, Weinblatt, Frank, Sager (1965) [US]	Leisure & Occupational (Travel to work)	11	Self or Interview Admin	Usual Activity - No specified time component	General	Developed many years ago, may not be relelvent to current time
8	Historical Leisure Activity Questionnaire	Kriska, Knowler, LaPorte et al (1990) [US]	Leisure	detail / table	Interviewer-admin	Retrospective recall of specific life periods	General	Only measures leisure activity
9	The Physical Activity Questionnaires of the Kuopio Ischemic Heart Disease Study (KIHD)	Salonen and Lakka (1987) [Scandinavia]	Leisure	17	Interviewer-admin	Varied	General, Heart Disease?	Only measures leisure activity
10	Lipid Research Clinics Questionnaire	Ainsworth, Jacobs, Leon (1993) [US]	Leisure & Occupational	4	Self-Admin	Usual Activity - No specified time component	General	Measures individual's perceptions
11	Minnesota Leisure-Time Physical Activity Questionnaire	Taylor, Jacobs, Shucker, Knudsen, Leon, DeBacker (1978)	Leisure & Household	detail / table	Interviewer-admin	Past 12 Months	General	Interviewer Assessed
12	Modifiable Activity Questionnaire	Kriska, Knowler, LaPorte (1990)	Leisure & Occupational	detail / table	Interviewer-admin	Past year and past week	General	Interviewer Assessed
13	Modifiable Activity Questionnaire for Adolescents		Leisure		Self-Admin	Past year	General	Only measures leisure activity and target population is adolescents

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
14	Paffenbarger Physical Activity Questionnaire	Paffenbarger, Wing, Hyde (1978) [US]	Leisure, Stairs/Walking	8 + table	Self or Interview Admin	Past week or past year	General	Limited to Leisure Activity
15	Seven-Day Physical Activity Recall	Sallis, Haskell and Wood (1985)	Leisure & Occupational	8 + detail	Interviewer-Administrated	Past 7 Days	General	Interviewer Assessed
16	Stanford Usual Activity Questionnaire	Sallis, Haskell, Wood, Fortmann, Rogers, Blair and Paffenbarger (1985) [US]	Leisure	11	Interviewer-Administrated	Usually activity, no specific time component OR past 3 Months	General	Interviewer Assessed
17	Tecumseh Occupational Physical Activity Questionnaire	Montoye, Remington, Napier, Metzner, Epstein (1967) [US]	Occupational and Non-Leisure, Travel	29	Self-Admin	Past year	General	Does not measure leisure activity
18	Modified Baecke Questionnaire for Older Adults		Leisure & Household		Interviewer-admin	Past year	General	Measure for Older Adults
19	Physical Activity Scale for the Elderly		Leisure, Occupational & Household		Telephone, personal interview, or self-administered by mail	Past 7 days	General	Measure for Older Adults

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
20	YALE Physical Activity Survey	DiPietro, Caspersen, Ostfield, Nadel (1993) [US]	Household, exercise and recreational	41	Interviewer-admin	A typical week in the preceding month	General	Interviewer Assessed
21	Zutphen Physical Activity Questionnaire	Caspersen, Bloemberg, Saris, Merritt, Kromhout (1985) [US]	Leisure	24	Self-Admin	Past-week, past-month, or usual activity with no specified time period	General, Older Adults	Measure more appropiate for Older Adults
22	Behavioral Risk Factor Surveillance System	Caspersen [US]	Leisure	19	Telephone Interview	Past Month	General	Interviewer Assessed
23	Canada Fitness Survey	Canadian Lifestyle and fitness Institute, Canada Fitness Survey (1983)	Leisure, Occupational & Household	15 + tables	Self-administered during a household visit	Daily and weekly, past month, and past year	General	Too long recall period
24	The MONICA Optional Study of Physical Activity (MOSPA)	Jones (1987) [US]	Leisure, occupational, transportation, and housework	38	Mainly self-administered, but some interviewer-admin	Usual activity with no specified time component and past year	General	Designed for correlations with cardiovascular risk factors
25	National Children and Youth Fitness Study I & II		Leisure and school activity		Self-Admin	Usual and past year	General	Measure for Children/Youth

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
26	National Health Interview Survey	Centres of Disease Control and Prevention, National Health Survey (1991) [US]	Leisure & Occupational	45 + detail	Interviewer-admin	Past 2 weeks	General	Interviewer Assessed
27	National Health and Nutrition Examination Survey I, II, and III	Centres of Disease Control and Prevention (1973) [US]	Leisure	22 + a little detail	Interviewer-admin	Past Month	General	Interviewer Assessed
28	Youth Risk Behavior Survey		Leisure and school activity		Self-Admin	Past week and past year	General	Measure for Children/Youth
29	Amherst Health & Activity Study: Adult Survey - For Children		Leisure and school activity		Admin by parents	Last 7 days	General	Measure for Children/Youth
30	Amherst Health and Activity Study (AHA) - For Students		Leisure and school activity		Self-Admin	Last 7 days	General	Measure for Children/Youth
31	International Physical Activity Questionnaires (IPAP)	Booth (1996) [Sydney]	Leisure, Occupational, Housework & Travel	15	Self-Admin (of adults young and middle aged)	Last 7 days	General (ages 18-69)	Appropriate for research
31a	International Physical Activity Questionnaires (IPAQ) SHORT		Leisure, Occupational, Housework & Travel	4	Self-Admin	Last 7 days	General	Limited length/data

#	Questionnaire	Developed By	Component Assessed	# of Items	Mode	Time-Frame	Target Population	Reason for Rejection
32	Project WALK	San Diego State University	Leisure – Walking	84	Self-Admin	Past 2 Weeks	General	Focus on walking
33	EPIC - Norfolk Physical Activity Questionnaire 2 - EPAQ2	MRC Epidemiology Unit	Household, Occupational, Leisure (see note)	97 + tables	Self-Admin	Last 12 Months		Too long recall period
35	Short Questionnaire to Assess Health-Enhancing Physical Activity (SQUASH)	Wendel-Vos, Schiut, Saris, Kromhout (2003) [Netherlands]	Travel, Leisure, Household, Occupatonal	11	Self-Admin	Average Week	General	Average week rather than previous week recall
36	Global Physical Activity Questionnaire (GPAQ)	WHO	Travel, Leisure, Household, Occupatonal	16	Interviewer-admin	Average Day & Week	General	Interviewer Assessed

A6 Community Sample Unrotated Component Matrix

Subscale	Item	Component				
		1	2	3	4	5
Barriers of Group Physical Activity	1	.474	.139	-.244	-.406	.491
	2	.513	.157	-.399	-.381	-.272
	3	.267	.526	-.103	-.399	.037
	4	.558	.184	-.414	-.394	.031
	5	.543	.098	-.315	-.449	-.253
Benefits of Group Physical Activity	6	.581	-.356	.365	-.063	-.078
	7	.562	-.538	.473	.066	-.089
	8	.579	-.454	.556	-.011	-.102
	9	.582	-.377	.509	.012	-.007
	10	.496	-.389	.459	-.001	.275
Barriers of Solo Physical Activity	11	.524	.239	-.247	.420	-.409
	12	.535	.112	-.506	.303	-.244
	13	.437	.026	-.480	.602	.039
	14	.422	.101	-.515	.369	.435
	15	.529	-.160	-.180	.149	.287
Benefits of Solo Physical Activity	16	.191	.711	.480	.034	-.041
	17	.101	.746	.462	.073	-.053
	18	.211	.651	.548	.113	.052
	19	.180	.741	.367	.045	.037
	20	.175	.599	.168	.178	.150

A7 Student Sample Unrotated Component Matrix

Subscale	Item	Component				
		1	2	3	4	5
Barriers of Group Physical Activity	1	.329	.485	-.135	.097	-.202
	2	.470	.389	-.174	.391	.115
	3	.562	.255	-.062	.368	-.178
	4	.363	.580	-.134	.216	.049
	5	.435	.560	-.017	.352	.151
Benefits of Group Physical Activity	6	-.530	.281	.432	.155	-.054
	7	-.675	.183	.470	.220	-.065
	8	-.619	.200	.483	.375	-.056
	9	-.632	.185	.238	-.008	.127
	10	-.495	.126	.378	.046	-.067
Barriers of Solo Physical Activity	11	-.104	.458	.003	-.357	-.583
	12	.008	.627	.236	-.049	-.189
	13	.012	.631	-.137	-.476	-.146
	14	.003	.630	-.165	-.353	.337
	15	-.374	.429	.074	-.246	.586
Benefits of Solo Physical Activity	16	.504	.021	.635	-.057	.189
	17	.539	.030	.616	-.111	.167
	18	.458	-.106	.630	-.138	-.152
	19	.550	-.135	.583	-.184	-.092
	20	.573	-.128	.291	-.074	.113

Appendix B Questionnaire Packs

B1 QuestionnairePack – Community Sample

Thinking about getting active?

This is a **survey** being conducted as part of PhD research by a student of the University of Edinburgh.

This can be completed by anyone in the household who is aged 18 or older. If required, you may have someone else translate this survey into English for you.

I would appreciate it if you could help me and complete this questionnaire booklet, and return it within 2 weeks.

Your response is voluntary, and you may drop out of this study at any time.

There are no right or wrong answers to any of the questions. It is your opinion that matters.

If you have any questions about this study please contact me.

Thank you for your time and effort in filling out this questionnaire.

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Questions About You

Please be assured that the following questions will be treated with strict confidentiality.

1. Are you;

- ☐ Male
- ☐ Female

2. What age are you? __________ years.

3. Are you;

- ☐ Single
- ☐ Married/Co-Habiting
- ☐ In a Relationship
- ☐ Widowed

4. Do you have any children?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

5. Are you;

- ☐ Unemployed
- ☐ Student
- ☐ Full-time Employed
- ☐ Part-time Employed
- ☐ Retired

6. What is your current or past occupation?

____

7. What is the highest level of education you have completed?

- ☐ School (GCSEs, O-Levels)
- ☐ College (A-Levels, vocational studies)
- ☐ Undergraduate Degree
- ☐ Postgraduate Degree
- ☐ Other? (Please Specify)

____

The following question is OPTIONAL.

It is important that you return the questionnaires to me as quickly as possible. Therefore if you do not wish to disclose the following information or do not know, then you can leave this section blank.

What is your height? (either feet and inches or centimeters and meters)

____

What is your weight? (either in pounds, stone or kilos)

____

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112. Do you participate in any group activities? Please state these below.

For example, group sports (e.g. football) or group exercises (e.g. exercise classes or yoga) or any other group physical activities (e.g. walking group). This also includes using gym equipment with friends.

What is your Group Activity? ______________________________

How **often** does your group meet? ______________________________

How much **time** do your spend doing this activity per meet? ______________

How many people are in your group, usually? ______________________

Any Comments? ______________________________

What is your Group Activity? ______________________________

How **often** does your group meet? ______________________________

How much **time** do your spend doing this activity per meet? ______________

How many people are in your group, usually? ______________________

Any Comments? ______________________________

☐ I **<u>do not</u>** participate in any **<u>group</u>** activities

Have you participated in group activity <u>in the past</u>?

What was your Group Activity? ______________________________

How **often** did your group meet? ______________________________

How much **time** did your spend doing this activity per meet? ______________

How many people were in your group, usually? ______________________

Why did you stop? ______________________________

____

113. Do you participate in any physical activity alone? Please state these below. For example, using equipment in a gym but not with friends, exercising at home, cycling alone or walks alone.

What is your activity? ____

How **often** do you do this activity? ____

How much **time** do your spend doing this activity per session? _______________________

Other comments? ____

What is your activity? ____

How **often** do you do this activity? ____

How much **time** do your spend doing this activity per session? _______________________

Other comments? ____

☐ I **<u>do not</u>** participate in any physical activity **<u>alone</u>**.

Have you participated in activity alone <u>in the past</u>?

What was your Activity? ____

How **often** did you do this activity? ____

How much **time** did your spend doing this activity per session? ______________________

Why did you stop? ____

____

____

I would like you to think about group activity.

Group Activity is described as 2 or more people who know each other, participating in physical activity or exercising together.

The following statements consider the pros and cons of group physical activity.

Please consider the statements below, and tick one box per statement showing how much you agree or disagree.

		Strongly Agree	Slightly Agree	Neither Agree nor Disagree	Slightly Disagree	Strongly Disagree
114	I would not know how to find or approach a group	☐	☐	☐	☐	☐
115	Others would want me to be competitive, and I do not wish to be	☐	☐	☐	☐	☐
116	I do not want to be obligated or committed to a group	☐	☐	☐	☐	☐
117	I would be concerned of how I might look	☐	☐	☐	☐	☐
118	Most people in sports groups play at a higher standard than me	☐	☐	☐	☐	☐
119	The encouragement from others would motivate me	☐	☐	☐	☐	☐
120	I would enjoy meeting others in a group	☐	☐	☐	☐	☐
121	I would enjoy making friends	☐	☐	☐	☐	☐
122	Committing to a group would make it more likely that I would attend	☐	☐	☐	☐	☐
123	I would rather learn about physical activities from taking part with others, than learning through reading.	☐	☐	☐	☐	☐

Anything you'd like to say about **group** physical activity?

____

____

I would like you to think about doing physical activity alone. The following statements consider the pros and cons of activity alone.

Please consider the statements below, and tick one box per statement showing how much you agree or disagree.

		Strongly Agree	Slightly Agree	Neither Agree nor Disagree	Slightly Disagree	Strongly Disagree
124	I would be worried about injuring myself	☐	☐	☐	☐	☐
125	I might not be doing it right	☐	☐	☐	☐	☐
126	I might be afraid of exercising alone	☐	☐	☐	☐	☐
127	I might feel silly exercising on my own	☐	☐	☐	☐	☐
128	I would be less motivated without the company of others	☐	☐	☐	☐	☐
129	Alone, I can go at my own pace	☐	☐	☐	☐	☐
130	I can participate when I want to, without having made arrangements with others	☐	☐	☐	☐	☐
131	I can set my own goals	☐	☐	☐	☐	☐
132	I can concentrate without being interrupted by others	☐	☐	☐	☐	☐
133	I don't have to talk to anyone	☐	☐	☐	☐	☐

Anything you'd like to say about doing physical activity **alone**?

___

___

___

___

134. **What kind of activities would you be interested in participating in?**

☐ Walking Group

☐ Tennis

☐ Badminton

☐ Football

☐ Frisbee

Other : ____

END OF QUESTIONNIARE

Thank you for completing this questionnaire, without you this study would not be possible!

Please return your completed questionnaire to me as soon as possible.

<u>Invitation to join in!</u>

In the future I intend to organise some activity groups for people like you, in your area. These will be for groups of people who have no or little experience with these activities, so please do not be discouraged if it is something that you have never done before, but might like to try, as there will be other people like you!

If you would like to participate in one of these groups, please leave your name and contact details below and indicate which activity you would like to do.

☐ Walking Group ☐ Football

☐ Tennis ☐ Frisbee

☐ Badminton Other : ______________________

Name : ____

Address : ____

____

____

Postcode : ____

Phone Number : ____

Email Address : ____

Best Time to contact you : ____

To ensure confidentiality (so your name cannot be connected to your questionnaire) these pages will be detached on receipt of your questionnaire, or you can detach this yourself.

Alternatively, If you would like to go on **walks alone** rather than join a walking group, if you complete the section below I will be able to send you this information.

Name : ____

Address : ____

____

____

Postcode : ________________________________

Phone Number : ________________________________

Email Address : ________________________________

Best Time to contact you : ____________________________

To ensure confidentiality (so your name cannot be connected to your questionnaire) these pages will be detached on receipt of your questionnaire, or you can detach this yourself.

Any other comments?

B2 Participant Information Sheet – Community Sample

SECTION OF CLINICAL & HEALTH PSYCHOLOGY
School of Health in Social Science
The University Of Edinburgh
Medical School
Teviot Place
Edinburgh EH8 9AG
Tel: 0131 651 3972
Fax: 0131 651 3971

PARTICIPANT INFORMATION SHEET

Study Title - Investigating Group Versus Solo Physical Activity Preference

My name is Julie Port and I am PhD research student at the University of Edinburgh. **As part of my PhD research, I invite you to take part in the following study**. However, before you decide to do so, I need to be sure that you understand firstly why I am doing it, and secondly what it would involve if you agreed. I am therefore providing you with the following information. Please read it carefully and be sure to ask any questions you might have, and, if you want, discuss it with others including your friends and family. I will do my best to explain the project to you and provide you with any further information you may ask for now or later.

BACKGROUND TO THE PROJECT

What is the project about?
Previous research has shown that there are a number of factors (for example, how much social support or encouragement you have) that can influence the amount of exercise or physical activity we do. Also previous research has shown that group activity can help motivate you to be more active than exercising alone. This study aims to analyse how these factors interact, in the eventual hope that something can be developed to help people become more physically active.

Why am I being asked to take part?
You are being asked to take part because you are a resident of Edinburgh. Your thoughts and opinions are important in further understanding the decisions that people make about taking part in physical activity. Your participation is completely voluntary.

How many other people are being asked to consider taking part?
400 others have been posted this questionnaire.

Will taking part be of benefit to me or others, now or in the future?
The information from this study will further the understanding of peoples' exercise behaviour and also help develop methods to help people become more active. You will be sent a summary of the study's findings which you may find interesting and possibly useful in understanding your own behaviour.

The results of the study may be published in academic journals in the area of health and physical activity and will be presented to fellow researchers via conference presentations and posters. **You will not be personally identified in any way in reports or publications.**

WHAT DOES THE PROJECT INVOLVE?

What will I be asked to do?
You are being asked to complete a questionnaire, and return it to me using the enclosed stamped addressed enveloped, within 2 weeks.

How long will I be involved?
The questionnaire should take less than 30 minutes to complete.

Will all people in the study do the same or will there be a control group?
Everyone in the study is given the same questionnaire to complete.

WHAT WILL HAPPEN TO THE INFORMATION YOU COLLECT ABOUT ME?

All information will be treated in the strictest confidence.

When I receive your completed questionnaire booklet**, all sections containing your name or details, will be removed from your questionnaire**. This ensures your anonymity, so no once can identify your questionnaire responses.

All data is stored in secure locations and only authorized personnel have access to it.

WHAT ARE MY RIGHTS?

You do not have to take part in this study and, even if you do, you are free to withdraw at any time without giving me any explanation. Also, this project, like other student projects, has been reviewed by a special ethics committee whose role is to protect your rights and safety and they have agreed that it can go ahead.

Thank you for considering to take part in my study!

PhD Research Student; Julie Port

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Medical School
Teviot Place
Edinburgh
EH8 9AG

Tel : 0131 650 3897
E-mail: J.Port@sms.ed.ac.uk

Name Of Supervisor; Dr. Paul Morris

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Medical School
Teviot Place
Edinburgh
EH8 9AG

B3 Questionnaire Pack –Student Sample

Thinking about getting active?

Physical Activity Student
Survey

The winner of the July 2008 Prize Draw has already been emailed. There will be another draw for £20 later in the year, all responses (from those who desire to be entered) from this date will be entered.

This is a survey being conducted as part of PhD research by a student of the University of Edinburgh.

Your response is voluntary, and you may drop out of this study at any time.

There are no right or wrong answers to any of the questions. It is your opinion that matters.

You participation is voluntary and you may cease to take part in this study at any time, without penalty.

At the end of the questionnaire you will be given an opportunity to enter your email address to be entered into a prize draw to win £20.

If you have any questions about this study please contact me.

Thank you for your time and effort in filling out this questionnaire.

For further information, please follow this link to a Participant Information Sheet - http://www.notzen.com/julie/StudentSheet.doc

Julie Port (M.Sc.)
Dept of Clinical & Health Psychology
Edinburgh University
Tel - 0131 650 3897
J.Port@sms.ed.ac.uk

1

Thinking about getting active?

Physical Activity Student Survey

Please be assured that the following questions will be treated with strict confidentiality.

*** 1. Are you a student at The University of Edinburgh?**

- ◯ Yes
- ◯ No
- ◯ Do not wish to answer

*** 2. What department are you from? (E.g. "Psychology")**

You may also write "Do not wish to answer".

[ ]

*** 3. What year are you in?**

- ☐ 1st Year (Undergraduate)
- ☐ 2nd Year (Undergraduate)
- ☐ 3rd Year (Undergraduate)
- ☐ 4th Year (Undergraduate)
- ☐ M.Sc. Year (Postgraduate)
- ☐ Ph.D. Year (Postgraduate)
- ☐ Do not wish to answer

Other (please specify)

[ ]

*** 4. Are you:**

- ◯ Male
- ◯ Female
- ◯ Do not wish to answer

2

* 5. What age are you?

Please answer in number of years, for example, if you are 18 please type "18".

If you do not wish to disclose your age, you may write "Do not wish to answer".

* 6. Are you:

- [ ] Single
- [ ] In a relationship
- [ ] Married/Co-habiting
- [ ] Widowed
- [ ] Do not wish to answer

* 7. Do you have any children?

- ○ 0
- ○ 1
- ○ 2
- ○ 3 or more
- ○ Do not wish to answer

* 8. If you had a career before coming to university or still do, what was/is your occupation?

If you do not wish to disclose this you may write "Do not wish to answer".

9. What are your parent's current or past occupation?

If you do not wish to disclose this you may write "Do not wish to answer".

10. THIS QUESTION IS OPTIONAL, you can leave this question blank.

What is your height? (either feet and inches or centimeters and meters)

11. THIS QUESTION IS OPTIONAL, you can leave this question blank.

What is your weight? (either in pounds, stone or kilos)

3

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Thinking about getting active?

Physical Activity Student Survey

19. Do you participate in any group activities? Please state these below.

For example, group sports (e.g. football) or group exercises (e.g. exercise classes or yoga) or any other group physical activities (e.g. walking group). This also includes using gym equipment with friends.

NOTE - More space below to detail activities.

What is your Group Activity?	
How often does your group meet?	
How much time do your spend doing this activity per meet?	
How many people are in your group, usually?	
Any Comments?	

20. Do you participate in any group activities? Please state these below.

What is your Group Activity?	
How often does your group meet?	
How much time do your spend doing this activity per meet?	
How many people are in your group, usually?	
Any Comments?	

21. Please indicate if you do not participate in any group activities.

○ I DO NOT participate in ANY group activities.

8

22. Have you participated in group activity in the past?

What was your Group Activity?	
How often did your group meet?	
How much time did your spend doing this activity per meet?	
How many people were in your group, usually?	
Why did you stop?	

23. Any other comments?

Thinking about getting active?

Physical Activity Student Survey

24. Do you participate in any physical activity alone? Please state these below. For example, using equipment in a gym but not with friends, exercising at home, cycling alone or walks alone.

NOTE - More space below to detail activities.

What is your activity?

How often do you do this activity?

How much time do your spend doing this activity per session?

Any Comments?

25. Do you participate in any physical activity alone?

What is your activity?

How often do you do this activity?

How much time do your spend doing this activity per session?

Any Comments?

26. Please indicate if you do not participate in any physical activity alone.

◯ I DO NOT participate in ANY physical activity ALONE.

27. Have you participated in physical activity in the past?

What was your activity?

How often did you do this activity?

How much time did your spend doing this activity per session?

Why did you stop?

10

28. Any other comments?

Thinking about getting active?

Physical Activity Student Survey

*** 29. Please indicate how much you agree with the following statements.**

	Strongly Agree	Slightly Agree	Neither Agree nor Disagree	Slightly Disagree	Strongly Disagree	Do not wish to answer
I would rather do physical activity ALONE	◯	◯	◯	◯	◯	◯
I would rather do physical activity with OTHERS or in a GROUP	◯	◯	◯	◯	◯	◯
I would prefer a group in which others were around the same level of ability as me	◯	◯	◯	◯	◯	◯

I would like you to think about GROUP ACTIVITY.

Group Activity is described as 2 or more people who know each other, participating in physical activity or exercising together.

The following statements consider the pros and cons of group physical activity.

*** 30. Please consider the statements below, and tick ONE CIRCLE per statement showing how much you agree or disagree.**

	Strongly Agree	Slightly Agree	Neither Agree nor Disagree	Slightly Disagree	Strongly Disagree	Do not wish to answer
I would not know how to find or approach a group	○	○	○	○	○	○
Others would want me to be competitive, and I do not wish to be	○	○	○	○	○	○
I do not want to be obligated or committed to a group	○	○	○	○	○	○
I would be concerned of how I might look	○	○	○	○	○	○
Most people in sports groups play at a higher standard than me	○	○	○	○	○	○
The encouragement from others would motivate me	○	○	○	○	○	○
I would enjoy meeting others in a group	○	○	○	○	○	○
I would enjoy making friends	○	○	○	○	○	○
Committing to a group would make it more likely that I would attend	○	○	○	○	○	○
I would rather learn about physical activities from taking part with others, than learning through reading.	○	○	○	○	○	○

31. Anything you'd like to say about group physical activity?

Thinking about getting active?

Physical Activity Student Survey

I would like you to think about doing physical activity ALONE. The following statements consider the pros and cons of activity alone.

*** 32. Please consider the statements below, and TICK ONE CIRCLE per statement showing how much you agree or disagree.**

	Strongly Agree	Slightly Agree	Neither Agree nor Disagree	Slightly Disagree	Strongly Disagree	Do not wish to answer
I would be worried about injuring myself	○	○	○	○	○	○
I might not be doing it right	○	○	○	○	○	○
I might be afraid of exercising alone	○	○	○	○	○	○
I might feel silly exercising on my own	○	○	○	○	○	○
I would be less motivated without the company of others	○	○	○	○	○	○
Alone, I can go at my own pace	○	○	○	○	○	○
I can participate when I want to, without having made arrangements with others	○	○	○	○	○	○
I can set my own goals	○	○	○	○	○	○
I can concentrate without being interrupted by others	○	○	○	○	○	○
I don't have to talk to anyone	○	○	○	○	○	○

33. Anything you'd like to say about doing physical activity ALONE?

14

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41. If you were to become active, what kind of activities would you be interested in participating in?

- ☐ Walking Group
- ☐ Tennis
- ☐ Badminton
- ☐ Football
- ☐ Frisbee

Other (please specify)

24

Thinking about getting active?

Physical Activity Student Survey

In the future I am hoping to continue my research with another study.

I am looking for people who would be interested in joining in with some sort of exercise or physical activity (for example, joining a jogging group).

If you think that you would like to join in, please register your interest below, and leave your email address so I can contact you about this in the future.

*** 42. Would you like to participate in a future study?**

◯ Yes (Please leave your email address below)

◯ No Thanks!

43. Would you be interested in receiving information in the future about doing physical activity alone, instead of with a group?

◯ Yes

◯ No thanks.

44. Please leave your email address if you wish to participate in a future study:

25

Thinking about getting active?

Physical Activity Student Survey

45. If you wish to be entered into a prize draw to win £20, you must enter your email address here:

46. Please tick this box if you would like to receive a summary of the study's findings (you must leave your email address to receive this).

- Yes, I would like to receive a summary of the study's findings.

Thank you for completing this questionnaire, without you this study would not be possible!

END OF QUESTIONNAIRE!

26

B4 Participant Information Sheet – Student Sample

YOU MAY KEEP THIS SHEET FOR YOUR OWN INFORMATION

SECTION OF CLINICAL & HEALTH PSYCHOLOGY
School of Health in Social Science
Teviot Place Medical Quad
Edinburgh EH8 9AG

PARTICIPANT INFORMATION SHEET

Study Title - Investigating Group Versus Solo Physical Activity Preference

My name is Julie Port and I am PhD research student at the University of Edinburgh. **As part of my PhD research, I'd like to invite you to take part in this study.**

This information sheet is intended to explain the reasons for the study and what it would involve if you agreed to take part. Please read this carefully and feel free to contact me to ask any questions you might have.

BACKGROUND TO THE PROJECT

What is the project about?
Physical activity is known to be important for the health and well being of people of all ages. However a previous large study found that the majority of students don't engage in sufficient levels of exercise.

We know that a number of factors can influence the amount of exercise or physical activity that we do. This study aims to evaluate some of these factors in a student population and to determine whether they differ between active and inactive individuals. It is intended that the study will help inform interventions which aim to help people become more physically active.

Why am I being asked to take part?
You are being asked to take part because you are a student at the University of Edinburgh. Your thoughts and opinions are important in helping us to understand the decisions that people make about taking part in physical activity. Your participation is completely voluntary.

Will taking part be of benefit to me or others, now or in the future?
The information from this study will further our understanding of peoples' exercise behaviour and help inform interventions that encourage people to become more physically active.

The study will have no direct benefit to you, though you may find it interesting to reflect on your own exercise behaviours.

WHAT DOES THE PROJECT INVOLVE?

What will I be asked to do?
You are being asked to complete a questionnaire.

How long will I be involved?
The questionnaire should take less than 30 minutes to complete.

Will all people in the study do the same or will there be a control group?
Everyone in the study is given the same questionnaire to complete.

WHAT ARE THE DISCOMFORTS OR RISKS?

If you feel uncomfortable about answering any of the questions, you can simply ignore these and move on to the other questions. If you score very highly on stress or depression, and you have left your email address, I will email you and tell you this.

WHAT WILL HAPPEN TO THE INFORMATION YOU COLLECT ABOUT ME?

All information will be treated in the strictest confidence.

When I receive your completed questionnaire, **any sections containing your email address or any other personal details will be separated from the rest of your data**. This ensures your anonymity.

All data will be stored securely within locked offices in Edinburgh University. Only myself and my supervisors will have access to the data.

WHAT ARE MY RIGHTS?

Participation in the study in entirely voluntary and you can withdraw from the study at any time. This project has been reviewed by an ethics committee whose role is to protect your rights and safety and they have agreed that it can go ahead.

PRIZE DRAW

The prize draw will be held on the 31st of July 2008 when data collection is complete. In order to be eligible you must provide an email address so that you can be contacted. A member of staff from the Department of Clinical and Health Psychology, unconnected to the study will pick one email address at random to receive a £20 cash prize. The winner will then be emailed regarding this, and further details will requested in order to give the winner the cash prize.

Thank you for considering taking part in my study!

PhD Research Student; Julie Port

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

Tel : 0131 650 3897
E-mail: J.Port@sms.ed.ac.uk

Name Of Supervisor; Dr. Paul Morris

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

B5 JogScotland Programme

jogscotland

Beginners: 5k Sample Training Programme
(5k = 3 Miles & 172 metres)

SET A GOAL BEFORE YOU START

Having a goal at the start of any exercise programme can be a great motivator and in many cases can make the difference between sticking with it or giving up.

For someone starting an exercise programme for the first time or just getting back into exercise after a long break it can be a difficult and daunting experience. How much should I do? How far should I run? What pace should I run at? What rest should I have between runs? These are all questions that are common, so if you have asked yourself any of them, don't worry – you're not alone!

GETTING STARTED

The good thing about starting out on a beginners programme is that the terms 'walk' and 'rest' are used quite a lot! Once you have decided on the run to take part in you should work backwards to however many weeks programme you are following. This sample programme lasts eight weeks and is aimed at getting you to the finish line. It assumes that you have no major health problems, are in reasonable shape, and have perhaps done at least some jogging or walking beforehand.

The following programme is only a suggestion and should be adapted to suit your work and home life and the days of the week that it is most convenient for you to exercise. As with all exercise programmes you should always do some gentle movement warm-up exercises beforehand and some stretching exercises to warm-down afterwards. If you have read this then you have taken the first steps towards getting fit enough for the 5k run! Happy running!

TERMINOLOGY

Walk: Brisk walking pace (faster than walking to the newsagents).

Jog: Gentle running pace (able to chat easily throughout).

Walk/Jog: Periods of walking followed by periods of jogging (vary the times and number of walks and jogs depending on total target time/distance).

Run: Faster pace than jogging but still able to chat (not continuously though!).

Rest: Either a day off exercise completely or other exercise such as swimming, aerobics or cycling.

www.jogscotland.org.uk

jogscotland

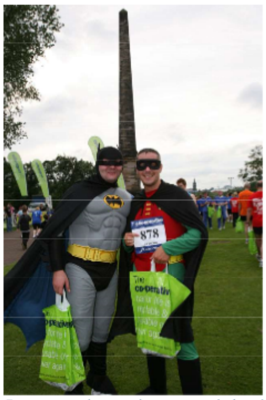
Beginners: sample 5k programme

Weeks until run	Mon	Tue	Wed	Thu	Fri	Sat	Sun
8	REST	1 mile walk/jog	REST	1 mile walk/jog	REST	30 minute walk	1 mile walk/jog
7	REST	1 mile walk/jog	REST	1 mile walk/jog	REST	30 minute walk	1 mile walk/jog
6	REST	1 mile walk/jog	REST	1 mile jog/run	REST	40 minute walk	1 mile jog/run
5	REST	1½ mile walk/jog	REST	1 mile jog/run	REST	40 minute walk	1½ mile jog/run
4	REST	1½ mile walk/jog	REST	1½ mile jog/run	REST	50 minute walk	2 mile jog/run
3	REST	1½ mile walk/jog	REST	1½ mile jog/run	REST	50 minute walk	2 mile run
2	REST	2 mile walk/jog	REST	2 mile jog/run	REST	60 minute walk	2½ mile run
1	REST	2 mile walk/jog	REST	1½ mile walk/jog	REST	REST	**5k run**

The programme is suggested advice and should be adapted to suit your work and home life and the days of the week that it is most convenient for you to exercise. Do not worry too much about exact distances, just try to cover the approximate time for each distance stated at your normal running pace.

As with all exercise programmes you should always do some gentle movement warm-up exercises beforehand and some stretching exercises to warm-down afterwards. As with any physical activity programme please consult your GP before commencing if you have any health concerns.

It's party time! You've done a 5k run!



Even super-heroes love a goody bag!

www.jogscotland.org.uk

B6 Consent Form

Section of Clinical and Health Psychology
SCHOOL OF HEALTH IN SOCIAL SCIENCE
The University of Edinburgh
Medical School
Teviot Place
Edinburgh EH8 9AG

INFORMED CONSENT FORM

Investigating Group Versus Solo Physical Activity

Julie Port

By signing this document you consent to participating in the study; "Investigating Group Versus Solo Physical Activity" being investigate by Julie Port, PhD Student at the Department of Clinical and Health Psychology.

This statement certifies the following: that you are 18 years of age or older and you have read the consent form, have had the opportunity to ask questions and are satisfied with the answers to any questions. You understand that you may withdraw from the study at any time.

A copy of the informed consent will be given to you.

____
Signature of Participant

____
Typed/printed Name

____
Date

PhD Research Student Julie Port

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

Tel : 0131 650 3897
E-mail: J.Port@sms.ed.ac.uk

Name Of Supervisor: Dr. Paul Morris

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

B7 Participant Information Sheet

Section of Clinical and Health Psychology
SCHOOL OF HEALTH IN SOCIAL SCIENCE
The University of Edinburgh
Medical School
Teviot Place
Edinburgh EH8 9AG

Telephone 0131 650 1000
or direct dial 0131 651

PARTICIPANT INFORMATION SHEET

Investigating Group Versus Solo Physical Activity

Julie Port

You have been asked to take part in a research project described below. The researcher will explain the project to you in detail. You should feel free to ask questions. If you have more questions later then Julie Port, the person mainly responsible for this study, will discuss them with you.

Description of the project

You have been asked to take part in the study that will investigate jogging behaviour in students. Physical activity is known to be important for the health and well-being of people of all ages. However a previous large study found that most students don't exercise enough. Current research suggests that exercising alone or in group may influence how much you exercise and how long you continue exercising for**.**

Procedures

If you decide to take part in this study this is what will happen:

You will be invited to join JogScotland, who are helping with this research project. You will be assigned to one of the following conditions, jogging in a group, or jogging alone. JogScotland will provide some guidance for those jogging alone. Those assigned to jogging in a group will have the opportunity to jog in a choice of groups which meet throughout the university campus. Jogging sessions should last no more than one hour including a warm up and down. This is something you do at your own risk and responsibility.

You will be asked to complete an online 15 minute questionnaire before you start jogging, after 5 weeks and finally after 10 weeks. You will be asked to note how often you go jogging per week.

On completion of this study you will be sent a one page summary of the study's findings (on checking a box on the online questionnaire).

Risks or discomfort

The researcher is responsible for the ethical conduct of the questionnaires. Choosing to exercise is your own risk and responsibility. If you have a concern concerning jogging, JogScotland can provide you with guidance on this, please see http://www.jogscotland.safety.ed.ac.uk/ for more details. If you feel uncomfortable about answering any of the questions in the questionnaire, you can simply ignore these and move on to the other questions.

Benefits of this study

Through regular exercise you can improve your health. Participating in this study will further our understanding of people's exercise behaviour and help inform future research. A one page summary of the main findings will be delivered to you if you chose to tick the appropriate box in the online questionnaire.

Confidentiality

Your part in this study is confidential. None of the information will identify you by name. All records will kept in a secure office, data will only be available for access by the researcher Julie Port, and her supervisors (Dr. P. Morris and Dr. E. Newman)

Voluntary participation and withdrawal

Participation in research is voluntary. You have the right to refuse to be in this study. **You have the right to drop out of this study at any time**. If you decide to be in the study and change your mind, you have the right to drop out at any time. **An ethics committee whose role is to protect your rights has reviewed this project and safety and they have agreed that it can go ahead.**

Questions, Rights and Complaints

If you have any questions about this research project, please call Julie Port at 0131 650 3897 (you may leave a message on the answer machine) or email at j.port@sms.ed.ac.uk . I will get back to you as soon as possible.

If you require impartial advice or wish to make a complaint, please contact:

Mr. Seamus Prior
Email - seamus.prior@ed.ac.uk
Tel - 0131 651 6599

B8 Jogging Diary

Thank you for taking part.

If you have any queries please email me at j.port@sms.ed.ac.uk

THE UNIVERSITY *of* EDINBURGH

jogscotland

Jogging Diary

On the inside, please write:

- Your name
- The date you go walking/jogging
- Any comments or thoughts you have about your experience

You will be given stickers when you attend your jogging group, please affix these to the spaces and note the length of time you exercised for.

You have space for 2 stickers, if you attend more or lose a sticker, make anote in the comments.

Name:

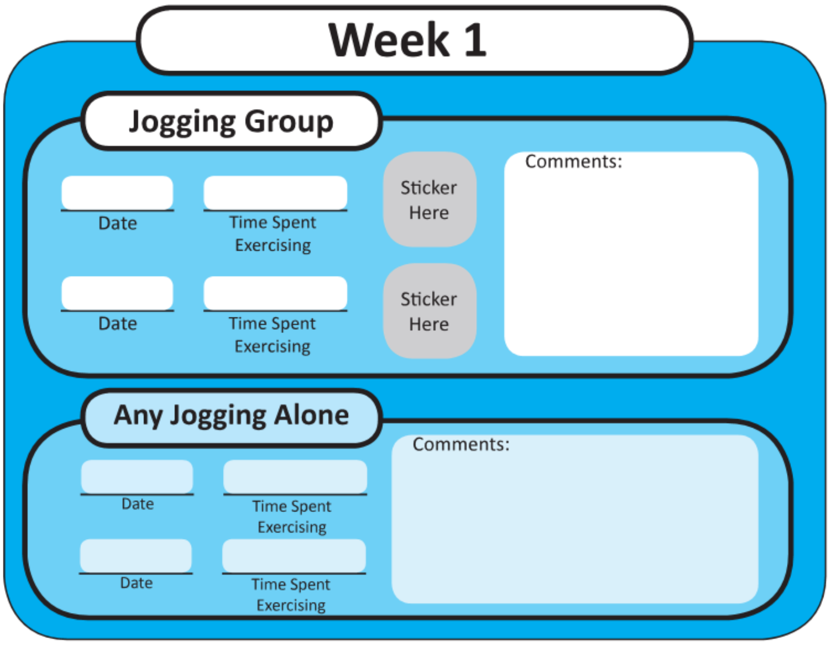
Please write your name above and fill in the online questionnaire, preferably before you start jogging, find it at:

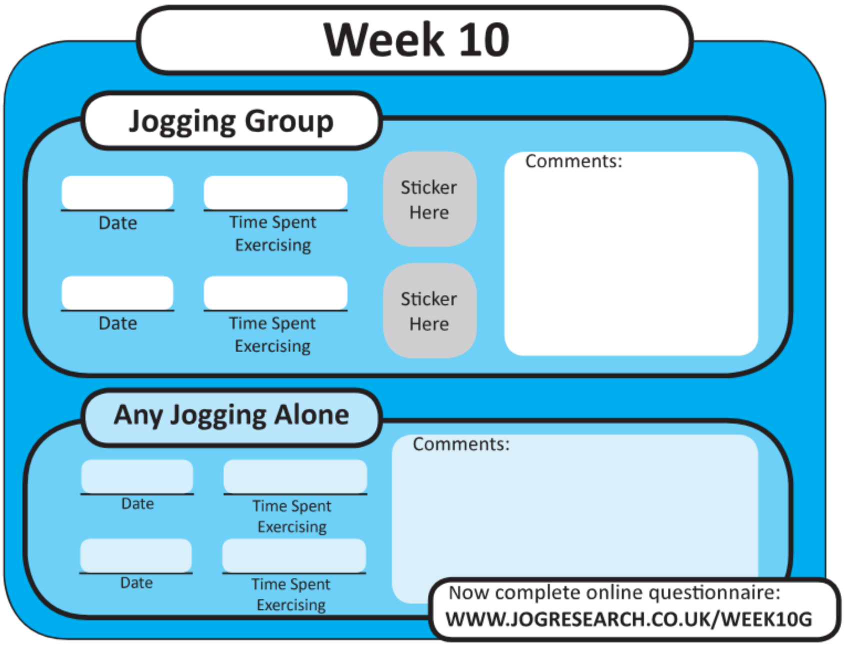
WWW.JOGRESEARCH.CO.UK/WEEK1G

Below is an example of how to fill in the diary. I have given you space to fill in any time you might go jogging alone. I do not expect you to do this at all, but just in case you did, I wanted to provide you with somewhere to record it.

If you have any questions or comments, email me at **j.port@sms.ed.ac.uk**

Thank you for participating!


Week 1
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:


Week 10
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:
Now complete online questionnaire:
WWW.JOGRESEARCH.CO.UK/WEEK10G

Any comments or notes:

EXAMPLE

Jogging Group

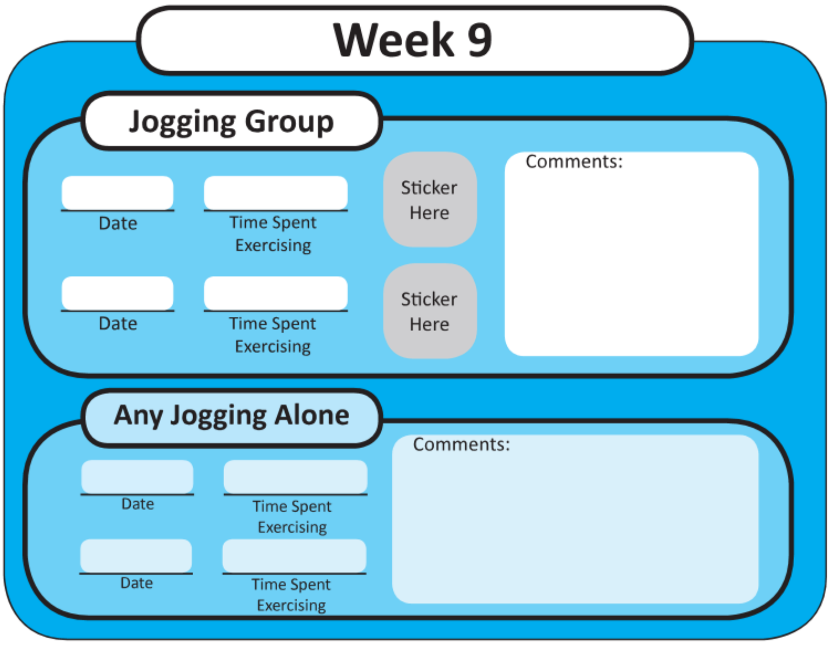
Date	Time Spent Exercising	Sticker
29/09/09	45 Minutes	Sticker Here
		Sticker Here

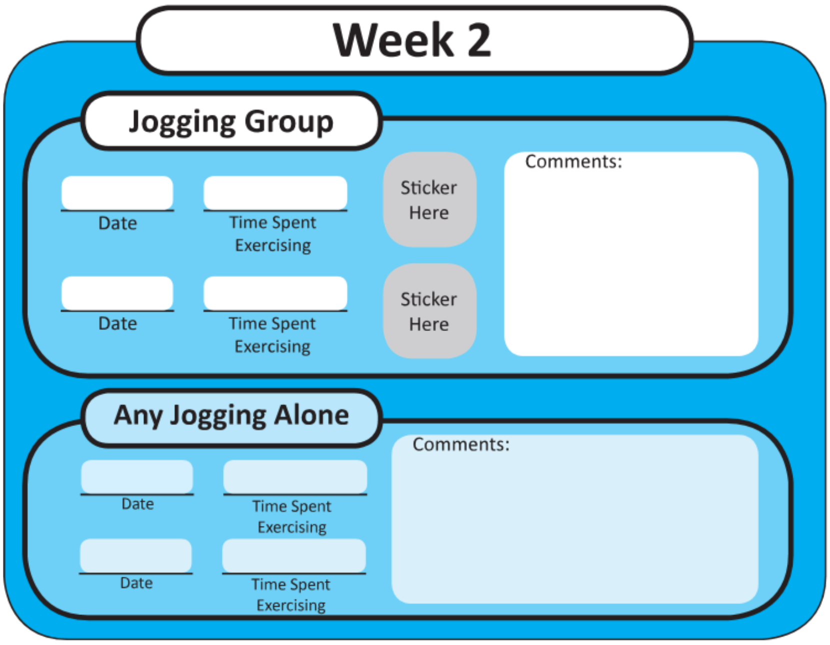
Comments:
It rained, but I looked forward to seeing the others in the group

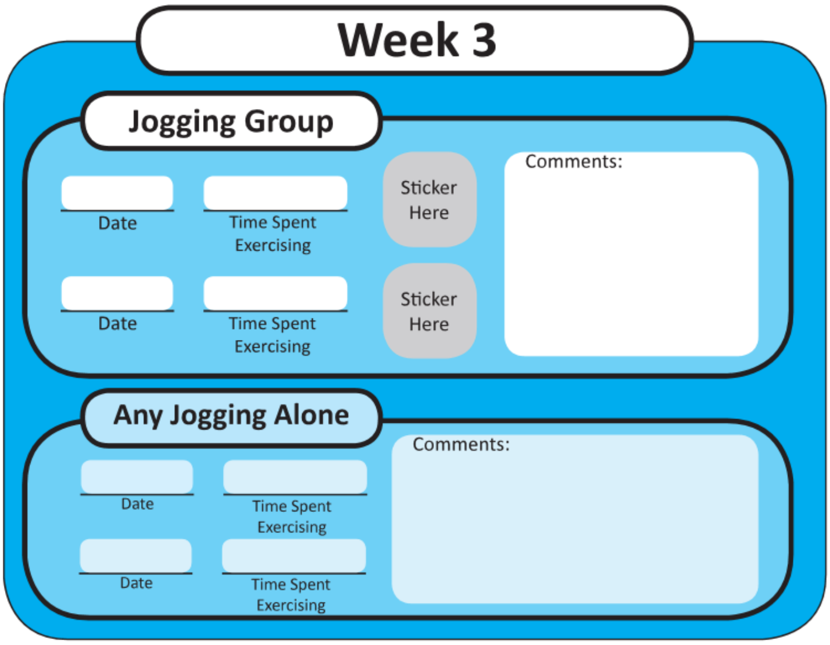
Any Jogging Alone

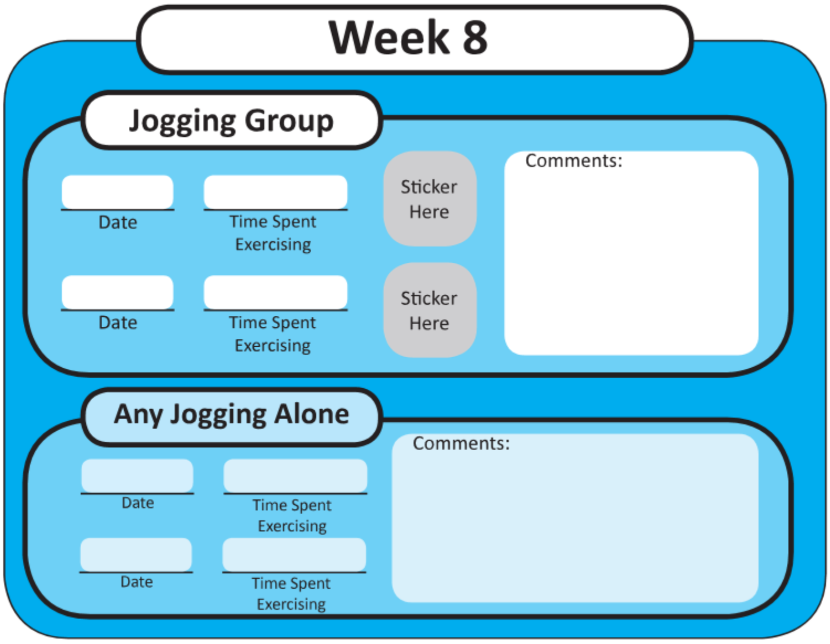
Date	Time Spent Exercising
1/10/09	30 Minutes

Comments:


Week 9
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:


Week 2
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:


Week 3
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:


Week 8
Jogging Group
Date
Time Spent Exercising
Date
Time Spent Exercising
Sticker Here
Sticker Here
Comments:
Any Jogging Alone
Date
Time Spent Exercising
Date
Time Spent Exercising
Comments:

Week 7

Jogging Group

Date | Time Spent Exercising | Sticker Here

Date | Time Spent Exercising | Sticker Here

Comments:

Any Jogging Alone

Date | Time Spent Exercising

Date | Time Spent Exercising

Comments:

Week 4

Jogging Group

Date | Time Spent Exercising | Sticker Here

Date | Time Spent Exercising | Sticker Here

Comments:

Any Jogging Alone

Date | Time Spent Exercising

Date | Time Spent Exercising

Comments:

Week 5

Jogging Group

Date

Time Spent Exercising

Sticker Here

Date

Time Spent Exercising

Sticker Here

Comments:

Any Jogging Alone

Date

Time Spent Exercising

Date

Time Spent Exercising

Comments:

Now complete online questionnaire:
WWW.JOGRESEARCH.CO.UK/WEEK5G

Week 6

Jogging Group

Date

Time Spent Exercising

Sticker Here

Date

Time Spent Exercising

Sticker Here

Comments:

Any Jogging Alone

Date

Time Spent Exercising

Date

Time Spent Exercising

Comments:

B9 Stickers Provided to Leaders

B10 Participant Information Sheet- TPB Study

SECTION OF CLINICAL & HEALTH PSYCHOLOGY

School of Health in Social Science

Teviot Place, Medical Quad

Edinburgh, EH8 9AG

PARTICIPANT INFORMATION SHEET

Investigating Group Versus Solo Physical Activity Using The Theory of Planned Behaviour

Julie Port

My name is Julie Port and I am PhD research student at the University of Edinburgh. **As part of my PhD research, I'd like to invite you to take part in this study**.

This information sheet is intended to explain the reasons for the study and what it would involve if you agreed to take part. Please read this carefully and feel free to contact me to ask any questions you might have.

Description of the project

You have been asked to take part in a study that will investigate attitudes to physical activity in students. Physical activity is known to be important for the health and well-being of people of all ages. However a previous large study found that most students don't exercise enough. Current research suggests that exercising alone or in group may influence how much you exercise and for how long you continue exercising**.**

Procedures

You are being asked to complete an online questionnaire. The questionnaire should take less than 30 minutes to complete. In order to be entered into the prize draw for a £5 gift voucher from Amazon.co.uk, you will need to leave a valid email address and complete the second questionnaire which will be emailed to you, two weeks later. The second questionnaire is much shorter and will take less than 10 minutes to complete.

Benefits of this study

The information from this study will further the understanding of peoples' exercise behaviour and also help develop methods to help people become more active if they wish to. You can be sent a summary of the study's findings (if you check the box indicating this when completing the questionnaire) which you may find interesting and possibly useful in understanding your own behaviour.

Confidentiality

Your part in this study is confidential. None of the information will identify you by name. All records will kept in a secure office, data will only be available for access by the researcher Julie Port, and her supervisors (Dr. P. G. Morris and Dr. E. Newman).

The results of the study may be published in academic journals in the area of health and physical activity and will be presented to fellow researchers via conference presentations and posters. **You will not be personally identified in any way in reports or publications.**

Voluntary participation and withdrawal

Participation in research is voluntary. You have the right to refuse to be in this study and have **the right to drop out of this study at any time**. If you decide to be in the study and change your mind, you have the right to drop out at any time. **An ethics committee whose role is to protect your rights has reviewed and approved this project.**

Prize Draw

The prize draw will be held on the 1st of June 2011 when data collection is complete. You must provide a valid email address so that you can be contacted if you are the winner. There will be a prize of a £5 gift voucher per 10 participants, so if 50 people enter, there will be 5 prizes of £5 vouchers each. A member of staff from the Department of Clinical and Health Psychology, unconnected to the study, will pick the email addresses at random to receive the £5 Amazon gift voucher. The winners will be emailed using the address provided.

Questions, Rights and Complaints

If you have any questions about this research project, please call Julie Port at 07882 045 320 (you can leave a message on the answer machine) or email at Julie.port@gmail.com . I will get back to you as soon as possible.

If you require impartial advice or wish to make a complaint, please contact:

Mr. Seamus Prior
Email - seamus.prior@ed.ac.uk
Tel - 0131 651 6599

Contact Information

Ph.D. Research Student;
Julie Port

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

Tel : 07882 045 320
E-mail: J.Port@sms.ed.ac.uk

Name Of Supervisor;
Dr. P. G. Morris

Clinical and Health Psychology
School of Health in Social Sciences
University of Edinburgh
Teviot Place
Edinburgh
EH8 9AG

B11 First Questionnaire – TPB Study

Your Thoughts about Physical Activity...

ONLINE SURVEY

At the end of the questionnaire you will be given an opportunity to enter your email address to be entered into a prize draw to win a £50 Amazon.co.uk gift voucher. In order to be entered into the prize draw, you must leave your email address and complete a further questionnaire in two weeks.

A link to the second questionnaire will be emailed to the address you provide. The second questionnaire will take no more than 10 minutes to complete. Once you have completed both questionnaires your email address will be entered into the prize draw.

The prize draw will be held on the 1st of June 2010. You must complete the second questionnaire before this date in order to be entered into the prize draw. To do this, you will have had to complete the first questionnaire before the 17th of May, in order to complete the final questionnaire 2 weeks later. The winner will be emailed the gift voucher, so please use a valid email address.

This is a survey being conducted as part of PhD research by a student of the University of Edinburgh.

Your response is voluntary, and you may drop out of this study at any time.

There are no right or wrong answers to any of the questions. It is your opinion that matters.

Your participation is voluntary and you may cease to take part in this study at any time, without penalty.

If you have any questions about this study please contact me at j.port@sms.ed.ac.uk

Thank you for your time and effort in filling out this questionnaire.

For further information, please follow this link to a Participant Information Sheet - http://www.julieport.com/StudyInfoSheet.doc

Julie Port (M.Sc.)
Dept of Clinical & Health Psychology
Edinburgh University
Tel - 07882 045 320
J.Port@sms.ed.ac.uk

1

Your Thoughts about Physical Activity...

Please be assured that the following questions will be treated with strict confidentiality.

*** 1. Are you a student at a university in Edinburgh?**

- Yes
- No
- Do not wish to answer

2. Which university do you attend?

- Edinburgh Napier University
- George Watson's College
- Queen Margaret University
- University of Edinburgh
- None of the Above
- Do not wish to answer

Other (please specify)

*** 3. What department are you from?**

- None
- Do not wish to answer
- Age detailed below:

Department:

2

*** 4. What year are you in?**

- ◯ 1st Year (Undergraduate)
- ◯ 2nd Year (Undergraduate)
- ◯ 3rd Year (Undergraduate)
- ◯ 4th Year (Undergraduate)
- ◯ 1st Year M.Sc.
- ◯ 2nd Year M.Sc.
- ◯ 1st Year Ph.D.
- ◯ 2nd Year Ph.D.
- ◯ 3rd Year Ph.D.
- ◯ 4th Year Ph.D.
- ◯ None of the Above
- ◯ Do not wish to answer

Other (please specify)

Your Thoughts about Physical Activity...

Please be assured that the following questions will be treated with strict confidentiality.

*** 5. Are you:**

- Male
- Female
- Do not wish to answer

6. What age are you?

Please answer in number of years, for example, if you are 18 please type "18".

- Do not wish to answer
- Age detailed below:

Age:

*** 7. Are you:**

- Single
- In a relationship
- Married/Co-habiting
- Widowed
- Do not wish to answer

*** 8. Do you have any children?**

- 0
- 1
- 2
- 3 or more
- Do not wish to answer

4

9. If you had a career before coming to university or still do, what was/is your occupation?

- ◯ No career
- ◯ Do not wish to answer
- ◯ Career Detailed Below:

Career:

10. What are your parent's current or past occupation?

- ◯ Do not wish to answer

Parents Career:

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Your Thoughts about Physical Activity...

In order to be entered into the prize draw for a £50 Amazon.co.uk gift voucher, you must note your email address and complete a further questionnaire in two weeks.

A link to the second questionnaire will be emailed to the address you provide. Once you have completed both questionnaires your email address will be entered into the prize draw.

77. All information will be treated with strict confidentiality.

If you wish to be entered into a prize draw to win a £50 Amazon.co.uk gift voucher, you must enter your email address here:

78. Please tick this box if you would like to receive a summary of the study's findings (you must leave your email address to receive this).

- ◯ Yes, I would like to receive a summary of the study's findings.
- ◯ No thank you

Thank you for completing this questionnaire, without you this study would not be possible!

END OF QUESTIONNAIRE!

B12 Second Questionnaire – TPB Study

Your Thoughts about Physical Activity...

1.
Start

Thank you for completing the questionnaire about physical activity two weeks ago.

This is the second questionnaire. If you complete this questionnaire and give your email address at the end, you will be entered into the prize draw for a £50 Amazon.co.uk gift voucher.

.

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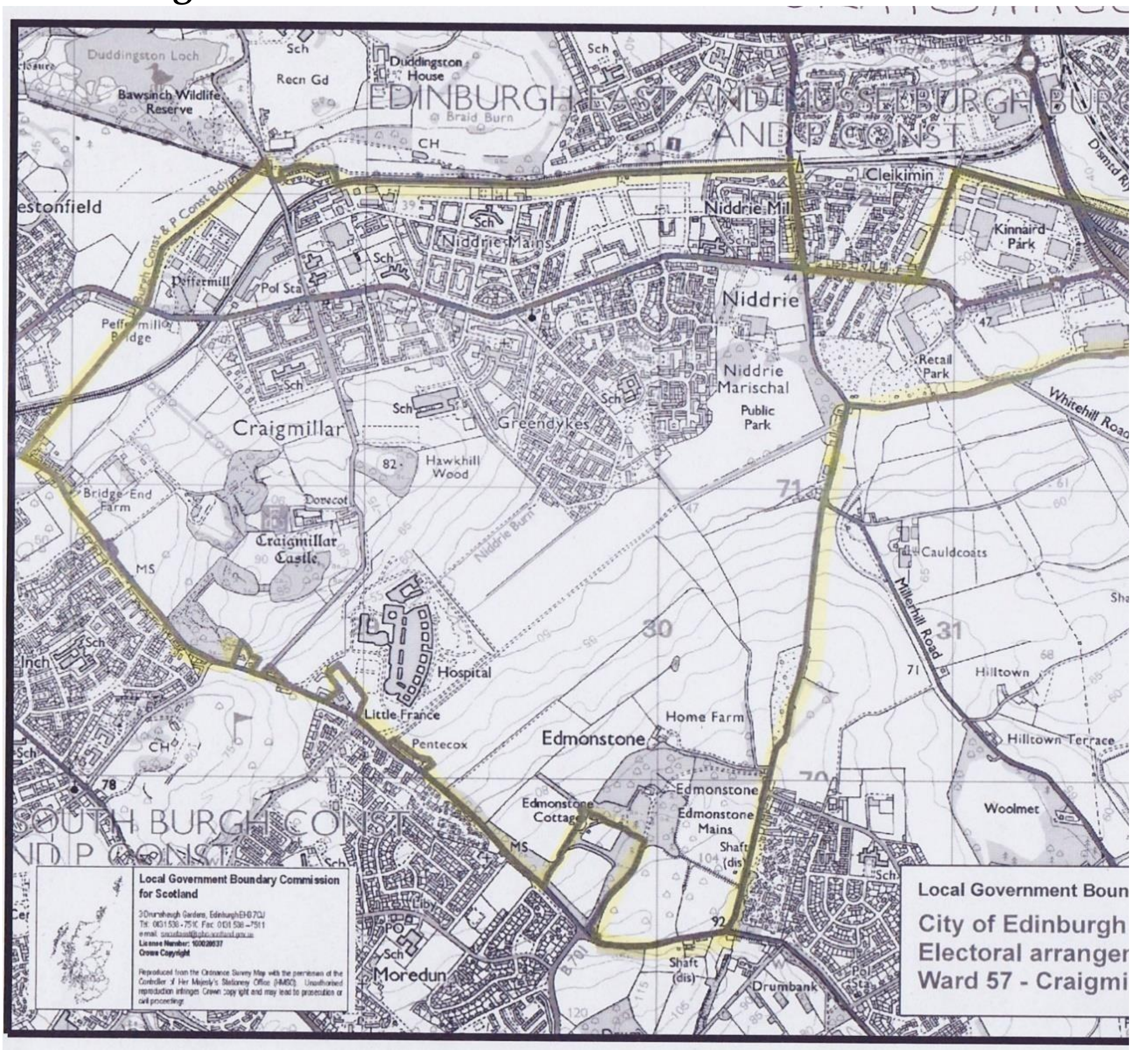
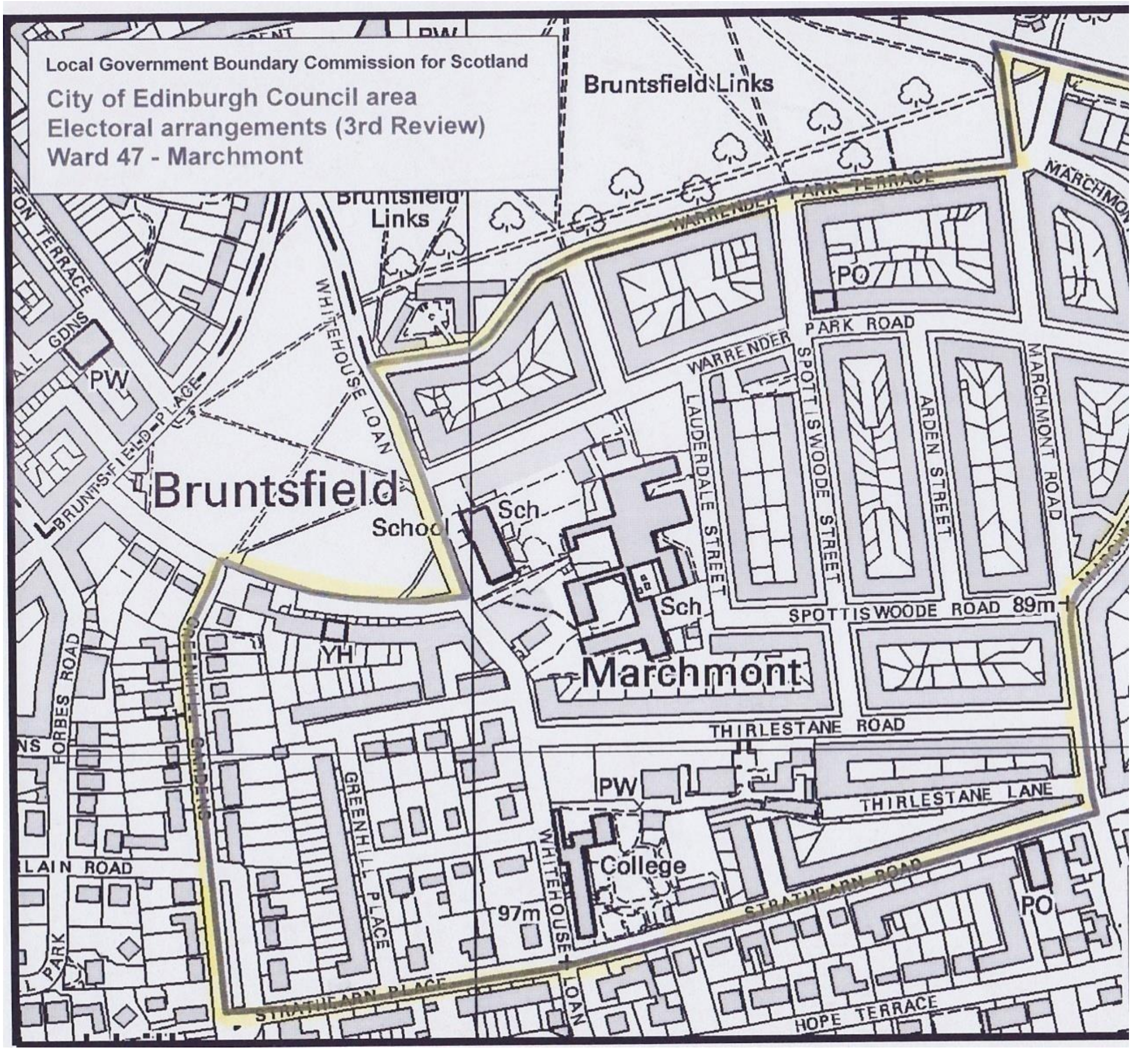
Appendix C Council Ward Maps

C1 Craigmillar



C2 Marchmont



C3 Portobello

Appendix D Ethics Approval

D1 Ethics Confimation For All Studies Except NRES

School *of* Health in Social Science
Department of Clinical and
Health Psychology

The University of Edinburgh
Medical School
Doorway 6, Teviot Place
Edinburgh EH8 9AG

Telephone 0131 651 3969
Fax 0131 650 3891

Julie Port
9/1 Dalgety Avenue
Edinburgh
EH7 5UF

18th December 2015

Dear Julie,

Thank you for your documentation regarding the three studies for your PhD thesis. I am pleased to confirm that the correspondence you have provided satisfies the University of Edinburgh's School of Health and Social Science requirements regarding ethical conduct of research. Given the unique circumstances we can issue a letter supporting the existing ethics approvals you have from the University. Details are as follows:

Project 1) Student Survey 2008
We confirm receipt of the IRAS approvals regarding this project. In addition based on your University REA application this project satisfies requirements for Level 1 ethical approval.

Project 2) Investigating Group versus Solo Physical Activity
We can confirm the correspondence with Dr Ethel Quayle represents University ethical approval for this project, based on the University Ethics system as it was in 2009.

Project 3) Comparing Group and Solo Physical Activity Using the Theory of Planned Behaviour
We can confirm the correspondence from the University Of Edinburgh / NHS (Scotland) Clinical Psychology Training Course, Research Ethics Meeting represents University ethical approval for this project, based on the University Ethics system as it was in 2010.

If you require any further clarification please do not hesitate to contact me.

Best wishes,

Dr Angus MacBeth
Lecturer in Clinical Psychology
Ethics Tutor

D2 NRES – Changes Required

23 November 2007

Miss Julie Port
PhD Research Student
The University of Edinburgh
Dept. Of Clinical Psychology
School of Health in Social Science
Medical School, Teviot Place
EH8 9AG

Dear Miss Port

Full title of study: **Investigating Group Versus Solo Physical Activity Preference**
REC reference number: **07/S1103/46**

The Lothian Local Research Ethics Committee 03 reviewed the above application at its meeting held on 21 November 2007. Thank you for attending to discuss the study.

Documents reviewed

The documents reviewed at the meeting were:

Document	*Version*	*Date*
Application	AB/122647/1	29 October 2007
Investigator CV	for Paul Graham Morris	23 October 2007
Investigator CV	for Miss Julie Port	23 October 2007
Protocol	1.0	23 October 2007
Covering Letter	1 - with original application	23 October 2007
Letter from Sponsor		23 October 2007
Compensation Arrangements	Statement of Indemnity	20 July 2007
Questionnaire	1.0	23 October 2007
Letter of invitation to participant	1.0 - included in booklet	23 October 2007
Participant Information Sheet	1.0	23 October 2007
Participant Consent Form	1.0 - included in booklet	23 October 2007

Provisional opinion

The Committee would be content to give a favourable ethical opinion of the research, subject to receiving a complete response to the request for further information set out below :

- The committee recommended that, in view of the fact that the study is questionnaire based, a written Consent Form was surplus to requirements as participants' completion of the questionnaire implied consent. This should also reassure participants of the anonymity of their completed questionnaires.
- In the Patient Information Sheet, reference to risks should be deleted.
- As certain healthcare problems are more prevalent in particular ethnic minority groups, the committee would prefer non-English speakers to be removed from the exclusion criteria.

D3 NRES – Confirmation

21 December 2007

Miss Julie Port
PhD Research Student
The University of Edinburgh
Dept. Of Clinical Psychology
School of Health in Social Science
Medical School, Teviot Place
EH8 9AG

Dear Miss Port

Full title of study: **Investigating Group Versus Solo Physical Activity Preference**
REC reference number: **07/S1103/46**

Thank you for your letter of 6 December 2007, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information was considered on behalf of the Committee by the Chair, Dr Christine West.

Confirmation of ethical opinion
On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Conditions of approval
The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents
The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Application	AB/122647/1	29 October 2007
Investigator CV	for Miss Julie Port	23 October 2007
Investigator CV	for Paul Graham Morris	23 October 2007
Protocol	1.0	23 October 2007
Covering Letter	1 - with original application	23 October 2007
Covering Letter	2 - with changes	06 December 2007
Letter from Sponsor		23 October 2007
Compensation Arrangements	Statement of Indemnity	20 July 2007
Questionnaire	2	06 December 2007
Letter of invitation to participant	1.0 - included in booklet	23 October 2007
Participant Information Sheet	1.0	23 October 2007
Participant Information Sheet	2	06 December 2007
Response to Request for Further Information		

Appendix E Advertising

E1 Student Flyer 1

E2 Student Poster 1

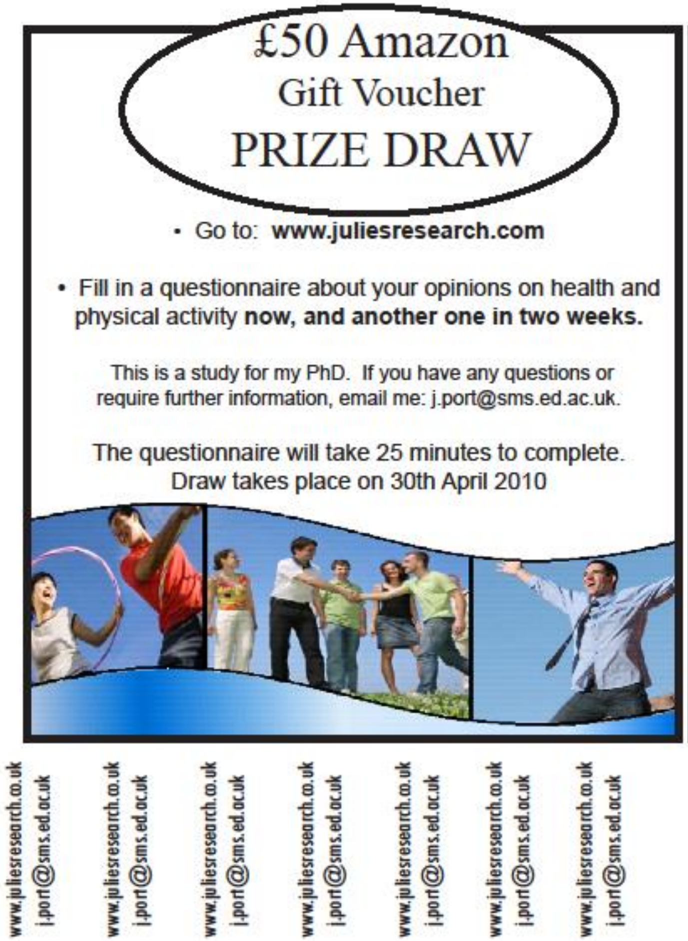
E3 Student flyer 2

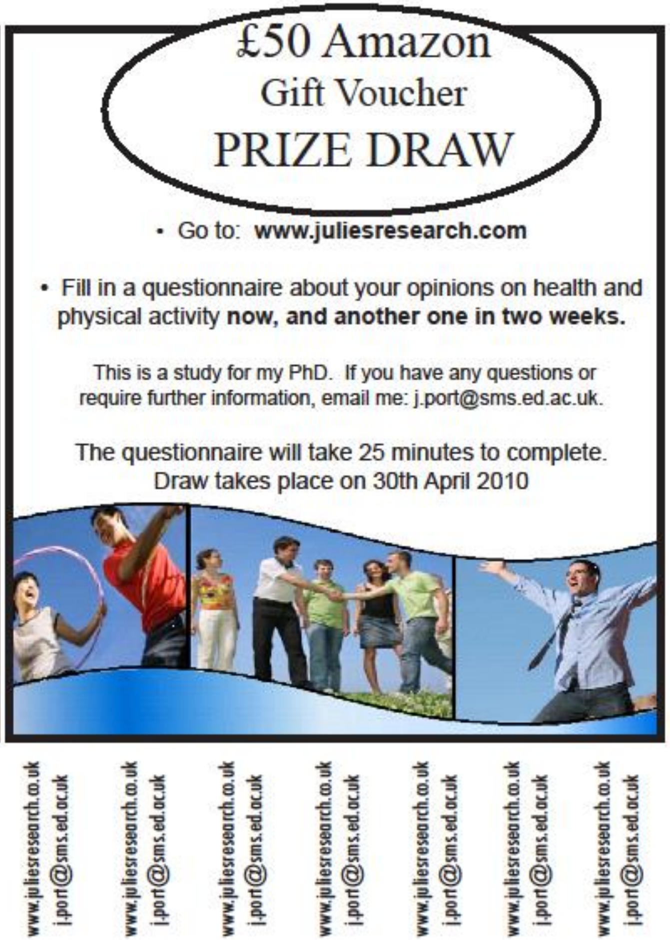
E4 Student poster 2

E5 TPB Flyer


£50 Amazon Voucher
Prize Draw
• Go to: www.juliesresearch.com
• Fill in a questionnaire about your opinions on health and physical activity now, and another one in two weeks.
This is a study for my PhD. If you have any questions or require further information, email me: j.port@sms.ed.ac.uk
The questionnaire will take 25 minutes to complete.
Draw takes place on 30th April 2010

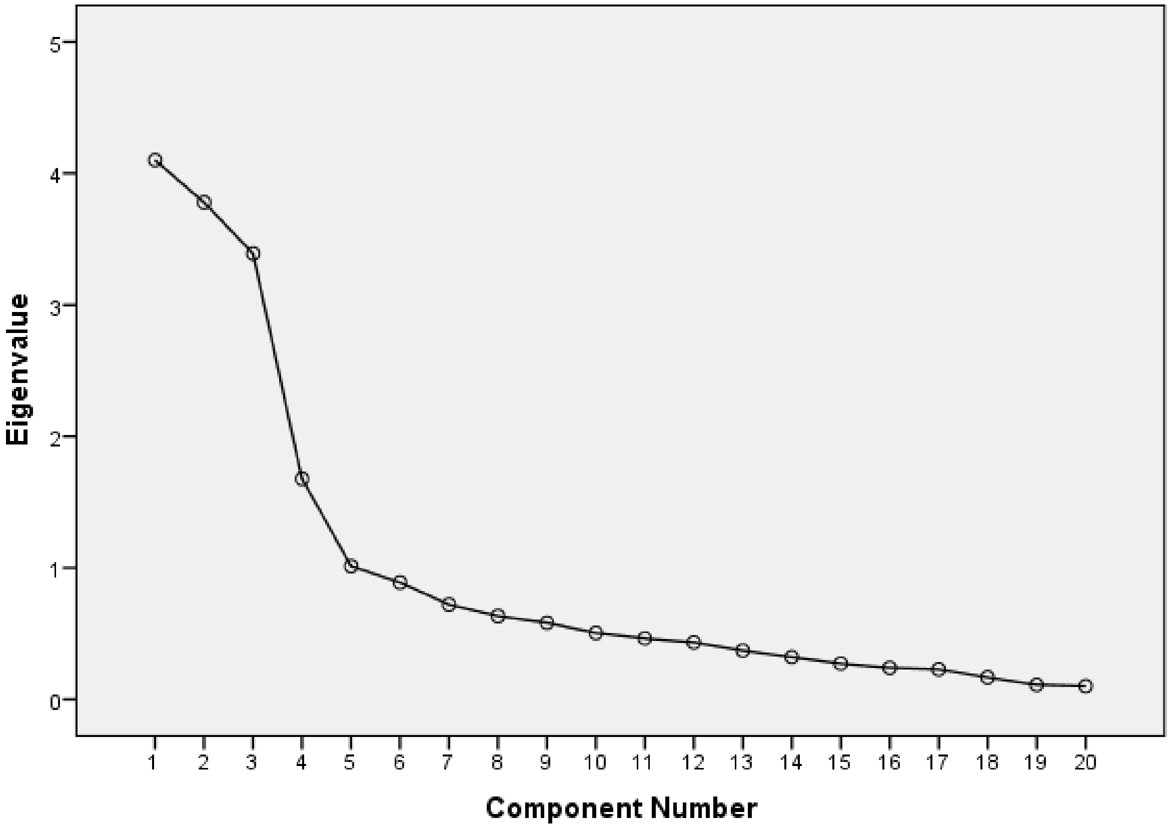
E6 TPB Poster



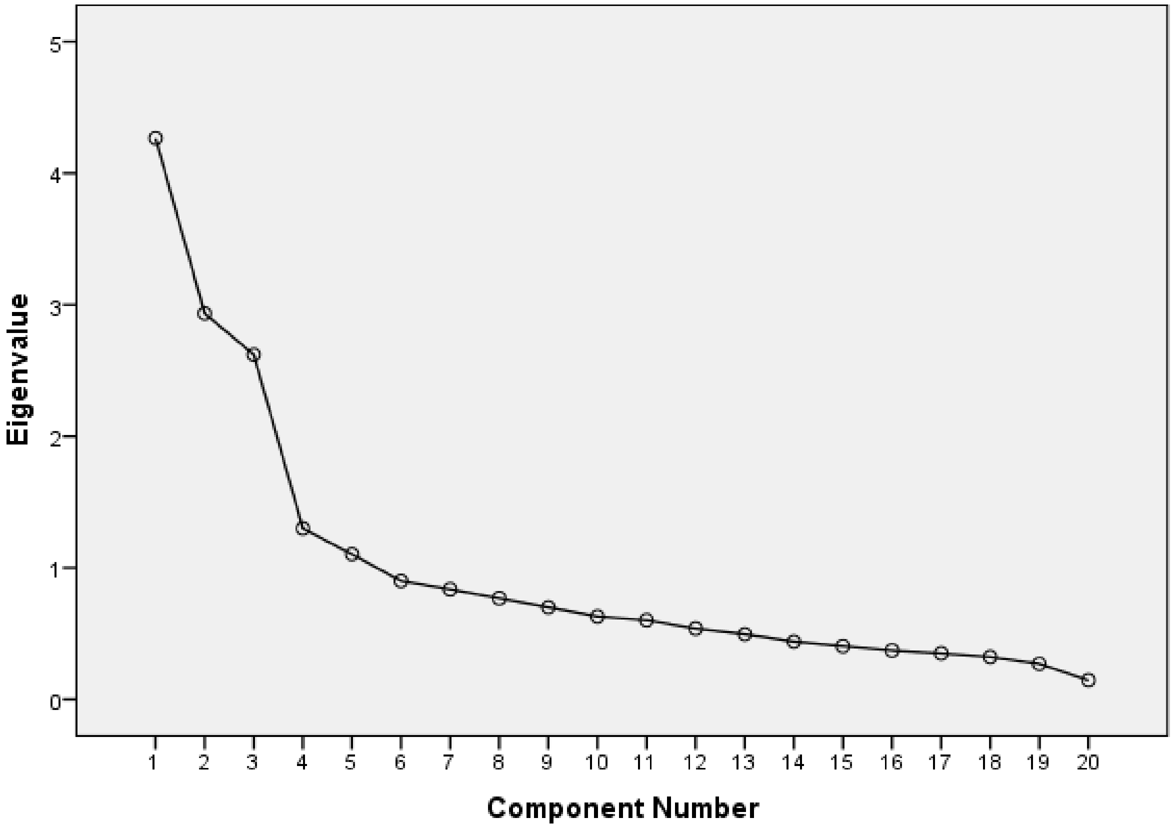


Appendix F Figures

F1 Community Sample Scree Plot



F2 Student Sample Scree Plot



Appendix G TPB Models

G1 Model 3

Relationship	Fully Constrained			
	Group Physical Activity		Group Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)
Intention				
Attitude	0.11 (0.02)***	0.31 (0.06)***	0.11 (0.02)***	0.15 (0.03)***
Subjective Norm	0.11 (0.03)***	0.18 (0.05)***	0.11 (0.03)***	0.09 (0.03)**
PBC	0.18 (0.02)***	0.46 (0.05)***	0.18 (0.02)***	0.46 (0.05)***
Behaviour/PA				
Intention	91.10 (24.58)***	0.30 (0.08)***	91.10 (24.58)***	0.26 (0.07)***
PBC	27.24 (12.15)*	0.22 (0.10)*	27.24 (12.15)*	0.09 (0.04)*
r^2 Intention				
r^2 Behaviour				
r^2 Overall				
X^2 By Group	A		a	
X^2 Overall	(11)=			
CFI				
RMSEA				
AIC				

a Not reported because of constraints between groups
* p<0.05; **p<0.01; ***p<0.001

G2 Model 6

Relationship	Fully Constrained			
	Group Physical Activity		Group Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)
Intention				
Attitude	0.07 (0.02)**	0.18 (0.06)**	0.07 (0.02)**	0.09 (0.03)**
Subjective Norm	0.08 (0.03)*	0.13 (0.05)*	0.08 (0.03)*	0.07 (0.03)*
Self-Efficacy	0.35 (0.04)***	0.59 (0.06)***	0.35 (0.04)***	0.24 (0.03)***
Controllability	<0.01 (0.04)	<-0.01 (0.05)	<0.01 (0.04)	<-0.01 (0.03)
Behaviour/PA				
Intention	99.63 (26.50)***	0.33 (0.09)***	99.63 (26.50)***	0.28 (0.07)***
Self-Efficacy	13.10 (20.22)	0.07 (0.11)	13.10 (20.22)	0.03 (0.04)
Controllability	43.64 (22.28)	0.17 (0.09)*	43.64 (22.28)	0.08 (0.04)
r^2 Intention	0.61		0.10	
r^2 Behaviour	0.22		0.10	
r^2 Overall	0.63		0.10	
X^2 By Group	A		a	
X^2 Overall	(13) = 41.77, p<0.01			
RMSEA	0.11			
CFI	0.89			

a Not reported because of constraints between groups
* p<0.05; **p<0.01; ***p<0.001

G3 Model 7 (specified by Chatzisarantis, Hagger & Brikell, 2008)

Relationship	Unconstrained			
	Group Physical Activity		Solo Physical Activity	
	b (SE)	β (SE)	b (SE)	β (SE)
Attitude				
PAS	0.71 (0.08)***	0.55 (0.05)***	0.40 (0.06)***	0.46 (0.06)***
Intention				
Attitude	0.08 (0.02)***	0.24 (0.06)***	0.13 (0.06)*	0.16 (0.07)*
Subjective Norm	0.08 (0.04)*	0.14 (0.06)*	0.08 (0.08)	0.07 (0.07)
PBC	0.13 (0.12)***	0.34 (0.06)***	0.42 (0.07)***	0.44 (0.06)***
PAS	0.11 (0.03)***	0.24 (0.07)***	0.06 (0.06)	0.08 (0.08)
Behaviour/PA				
Intention	83.80 (39.60)*	0.26 (0.12)*	104.49 (38.12)**	0.31 (0.11)**
PBC	25.96 (13.89)	0.22 (0.11)	66.05 (37.48)	0.21 (0.011)
PAS	1.04 (16.92)	0.01 (0.12)	-38.71 (23.72)	-0.16 (0.10)
r^2 Attitude	0.31		0.21	
r^2 Intention	0.54		0.32	
r^2 Behaviour	0.19		0.17	
r^2 Overall	0.58		0.43	
X^2 By Group	X^2 (5) = 19.20, p<0.01		X^2 (6) = 16.77, p=0.01	
X^2 Overall	X^2 (14) = 35.96, p<0.01			
RMSEA	0.09			
CFI	0.94			
AIC				

* p<0.05; **p<0.01; ***p<0.001

G4 Model 8 – Step 1

Relationship	Unconstrained			
	Group Physical Activity		Group Physical Activity	
	b (SE)	b (SE)	b (SE)	b (SE)
Intention				
Attitude]	0.11 (0.02)***	0.31 (0.06)***	0.15 (0.06)*	0.17 (0.07)*
Subjective Norm	0.12 (0.04)***	0.20 (0.06)***	0.16 (0.08)	0.09 (0.07)
PBC	0.16 (0.02)***	0.40 (0.05)***	0.45 (0.06)***	0.46 (0.06)***
Behaviour/PA				
Intention	84.91 (34.42)*	0.27 (0.11)*	87.33 (37.09)*	0.26 (0.11)*
PBC	26.15 (13.67)	0.22 (0.11)	52.20 (36.97)	0.16 (0.11)
r^2 Intention	0.55		0.32	
r^2 Behaviour	0.19		0.14	
r^2 Overall	0.57		0.34	
X^2 By Group	X^2 (4) = 0.83, p=0.93		X^2 (5) = 11.20, p=0.05	
X^2 Overall	X^2 (12) = 12.03, p=0.44			
RMSEA	<0.01			
CFI	1.00			

* p<0.05; **p<0.01; ***p<0.001